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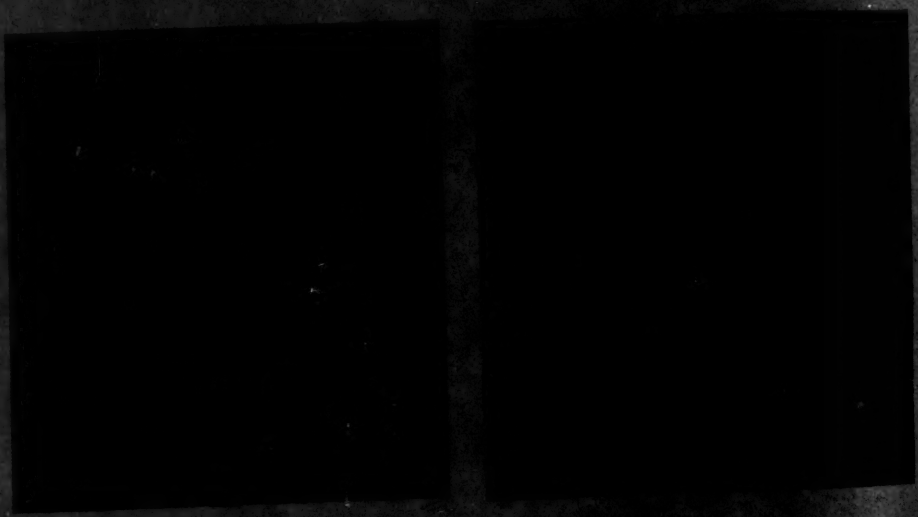

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OPHTHALMOLOGY

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COMMUNICATIONS

FAILING VISION CAUSED BY A BONY SPIKE COMPRESSING THE OPTIC NERVE WITHIN THE OPTIC CANAL*

REPORT OF TWO CASES ASSOCIATED WITH MORGAGNI'S SYNDROME BENEFITED BY OPERATION

BY

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IN this paper we seek to draw attention to a hitherto undescribed condition, in which an optic nerve is compressed and indented by a bony spike projecting into the optic canal (optic foramen). We have encountered two cases, both of which were benefited by decompressing the optic nerve, and we desire to emphasize the need for recognizing the condition when it is present. The pathological condition underlying both our cases was Morgagni's syndrome. This is a disease of obscure aetiology, which occurs in middle-aged women, and is characterized by hyperostosis frontalis

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interna, obesity, and hirsuties, and sometimes by mental disturbances. It would seem that the bony spikes, situated in our two cases within the optic canals, were of similar origin to the spikes or osteophytes arising elsewhere from the inner table of the skull.

Case Histories

Case 1.—This patient, a 37-year-old single woman, was referred, in June, 1948, by Dr. R. P. Wilson and Prof. F. H. Smirk with a serious loss of vision in her right eye. Since childhood, she had been blind in her left eye as the result of an injury. Eight years ago she had noticed a slight dimness of vision in her seeing eye, particularly for distant landmarks, and this had remained stationary for six years. Then, during the last two years, her vision had become progressively more blurred, until she had difficulty in discerning even large objects. Throughout this latter period she had experienced attacks of "blacking out" of vision, which would appear without apparent reason and last a few seconds.

FIG. 1.—Case 1, general build.

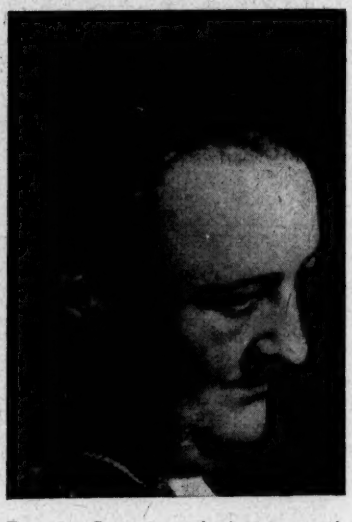

FIG. 2.—Case 1, scalp incision and shaven face on 12th post-operative day.

She also had several other symptoms. Since childhood, she had suffered from recurrent attacks of "acute articular rheumatism" in various joints, large and small, of her limbs. For ten years, she had complained of severe frontal headaches which appeared in attacks several times a month, and lasted from a few minutes to two days. Two years before admission, she had developed an abnormal thirst, drinking large quantities of water daily and passing correspondingly large volumes of urine, but this had since lessened. During this period of abnormal thirst, she had exhibited a disturbance of her sleep-rhythm, finding difficulty in sleeping by night. She had also complained of ringing noises in her right ear,

which was gradually becoming deaf. Her menses had commenced at the age of eleven years, but her periods had always been irregular and often overdue. Recently there had been an increased menstrual loss. At the age of sixteen years, an ovarian cyst had been removed, shortly afterwards she had rapidly increased in weight. For many years she had taken thyroid tablets 2 gr. daily to keep her weight down, but in spite of this her weight had remained at about 16 stone. Mentally she had always been normal, she successfully ran a second-hand shop, and was by all accounts an astute business woman. Her family history seemed uneventful, except that all the members were "large".

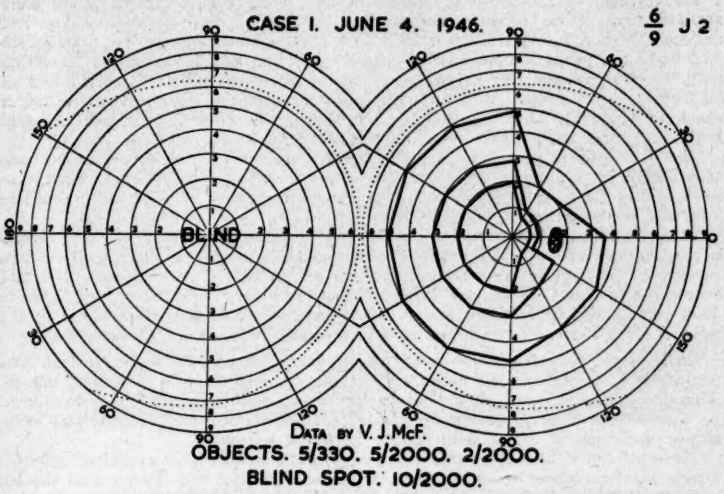

FIG. 3.—Case 1, visual fields charted 2 years before admission.

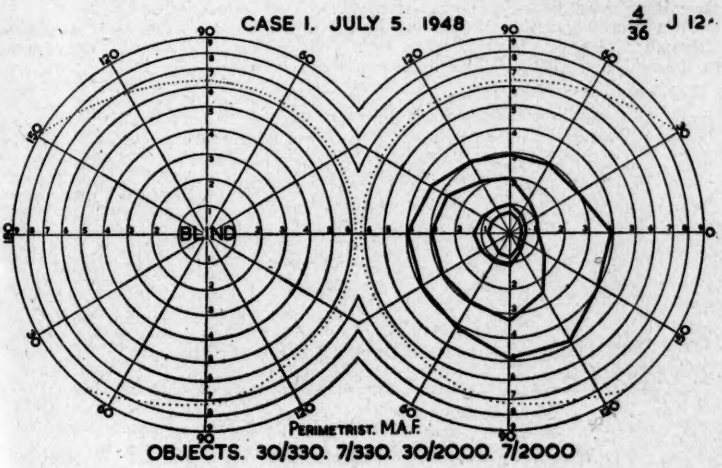

FIG. 4.—Case 1, visual fields charted shortly before operation.

Examination.—An alert and cheerful woman, of large and heavy build, with gross obesity involving mainly the trunk and proximal portions of the limbs (Figs 1 and 2). Height, 5 ft. 9½ in. Weight 16 st. 8 lb. She shaved daily, and exhibited hair on her chest, although the pubic hair distribution was feminine.

Ophthalmological Examination.—Visual acuity: right eye—4/36, J. 12 (corrected); left eye—blind. The right eyeball presented a low degree of myopia (−1·0 D.S.), its tension was normal, and its conducting media were clear. The optic disk was pale in its nasal half, but otherwise was normal. The retinal vessels were also normal.

Visual field charts taken at intervals during the two preceding years were available, and these showed that during this period her distance acuity had declined from 6/9 to less than 6/60. The decline in reading vision from J.2 to J.12 had been proportionately less, suggesting that an additional factor connecting with her myopia was also operating. The original chart showed constriction of all isopters of the right field, but chiefly on the temporal side and in the upper quadrant (Fig. 3). By the time of admission, this constriction had increased but no sector-shaped defect reaching the blind spot was detected (Fig. 4).

The left eyeball presented an old-standing traumatic cataract, and this was associated with a slightly divergent and concomitant squint. The movements of each eyeball were full. Pupils were approximately equal in size, and reacted to light and convergence.

Other Systems.—Apart from slight bilateral deafness, examination of the central nervous system resulted in negative findings. There was a slight goitre. The cardiovascular system also seemed normal (B.P. 125/85). Her fluid intake averaged 2700 to 4700 cc. *per diem*, while the urinary output averaged 1200 to 2700 cc. Transient swelling and crepitus were noted in both wrists and in the right ankle. Passive movements at the hip-joints were markedly reduced.

Radiological Examinations.—Views of the skull showed numerous osteophytes projecting inwards from the inner table of the vault in the frontal region (Fig. 5). These osteophytes were symmetrically arranged, and in places were confluent. In the midline they projected on either side of the superior longitudinal sinus almost enclosing it. The sella turcica appeared normal.

Views of the right optic canal revealed a blunt spike of bone projecting about 2 mm. into the lumen from its lower and inner part (Fig. 6). By contrast the left optic canal appeared round.

Lumbar Encephalography outlined a normal ventricular system. The basal cisterns filled normally with the air, and the silhouettes of the optic nerves in their intracranial course appeared normal and free from compression.

Plain *x*-rays of various joints and long bones showed no definite abnormality, although *x*-rays of the feet, taken four years earlier, had shown some lipping in the mid-tarsal joints. This lipping had since disappeared.

Laboratory Procedures:

(a) Basal metabolic rate, -9 to -6 per cent.

(b) Glucose tolerance test (50 g. glucose ingested).

Specimen	Blood sugar %	Urine sugar
Resting	0·16	Nil
½ hour	0·27	
1 hour	0·22	
2 hour	0·17	3+

(c) Lumbar cerebrospinal fluid—normal.

(d) Blood count and sedimentation rate—normal.

(e) Blood chemistry:

Serum calcium	-	9·9 mg. per 100 cc.
Blood cholesterol	-	330 mg. per 100 cc.
Blood uric acid	-	3·5 to 7 mg. per 100 cc.

(f) Wasserman reaction—negative in both blood and cerebrospinal fluid.

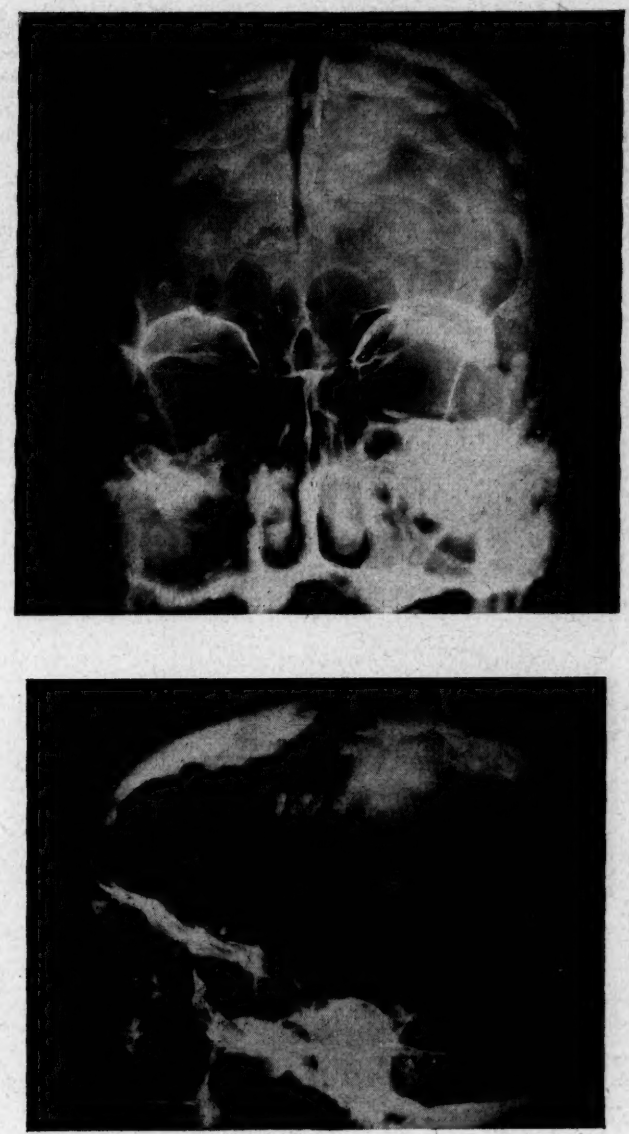

FIG. 5 (a) and (b).—Case 1, *X* rays of skull showing extensive hyperostosis frontalis interna.

Summary.—A progressive failure of vision had occurred, the visual acuity having fallen from 6/9 to 4/36 in the preceding two years. *X* rays had disclosed a bony spike projecting into the right optic canal in its lower and inner part, and the position of this spike could be correlated with the site of maximum impairment of the visual field in the upper temporal quadrant. In the absence of any other demonstrable cause, this spike was therefore presumed to be the lesion responsible for the visual failure. As the other eye was blind, and the visual loss in the seeing eye had reached a very serious level, exploration of the optic nerve within its canal was decided on.

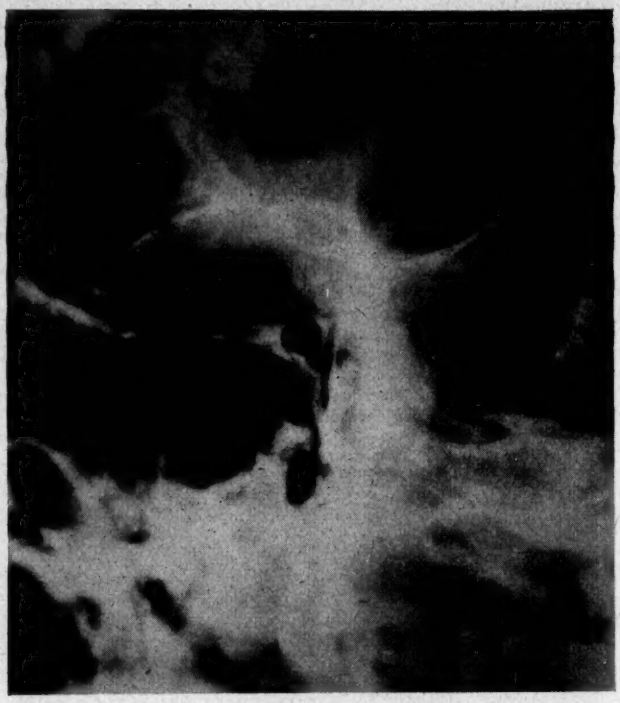

FIG. 6.—Case 1, *X* ray of right optic canal showing bony spike projecting into canal from its lower and inner part.

Operation.—Under intratracheal anaesthesia, a right frontal craniotomy of the type used for a subfrontal pituitary exposure was performed (M.A.F.). Difficulty was encountered in separating the skull from the underlying dura because of osteophyte-formation. The dural envelope surrounding the frontal lobe was elevated off the anterior cranial fossa, and was incised in front of the sphenoidal ridge, exposing the intracranial portion of the right optic nerve and the chiasm. No abnormality was here seen. Next, a burr-hole was made in the orbital plate of the frontal bone, and from this starting point the roof of the orbit was removed piece by piece in a backward direction towards the optic canal. Then, the wall of the canal itself was removed on its superior and lateral aspects, so

decompressing the optic nerve (Figs 7 and 8). It was not possible to gain access to the floor of the canal below the optic nerve, and so the actual bony spike was not disturbed. After haemostasis was secured, the craniotomy was closed.

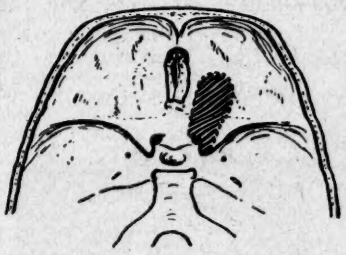

FIG. 7.—Diagram indicating amount of bone removed from anterior cranial fossa to decompress the right optic canal.

Post-operative Course—Convalescence was uneventful. Three weeks later, when she was discharged from hospital, her visual acuity had improved to 6/12 and J.6, while her visual field had filled out except for a sector-shaped defect reaching the blind spot from the upper temporal quadrant (Fig. 9). Shortly afterwards, Dr. Wilson reported that her acuity had reached 6/4 partially, and had then deteriorated slightly.

Later Progress.—When seen again by us 14 months later, she said that, apart from a slight and transient impairment which occurred shortly after her return home and was corrected by a change of spectacles, the vision in her right eye had remained good. She could see to read a newspaper, sew, and drive a motor-car, and had resumed all her former activities. Headaches had been slight.

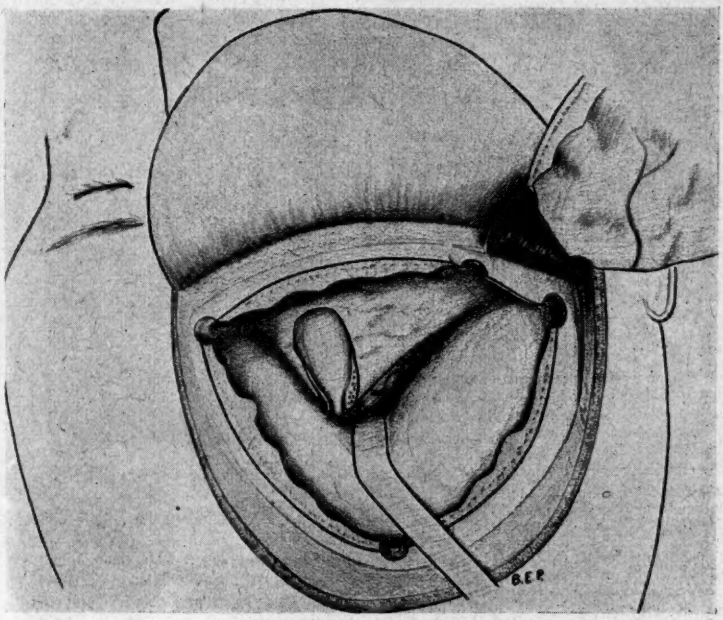

FIG. 8.—Assistant's sketch illustrating operative exposure. The right frontal lobe has been elevated, and the optic canal decompressed. Notice the optic nerve freed within the canal.

Her menses were still irregular. On examination her visual acuity was 6/9 partially and J.4 (Fig. 10). The optic disk was now definitely pale while the visual field showed no essential change from that charted at the time of discharge, although the limits of the sector-shaped defect were perhaps more definite.

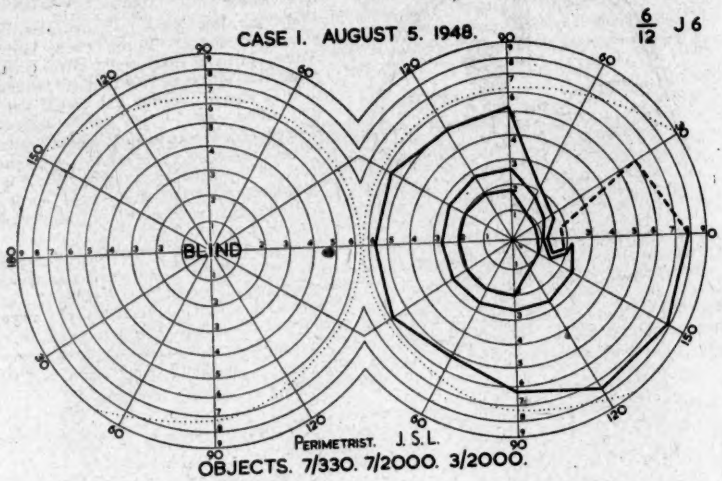

FIG. 9.—Case 1, visual fields charted 3 weeks after operation.

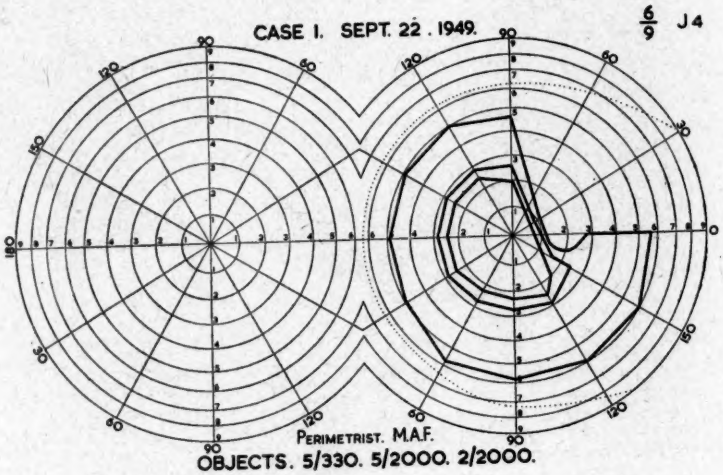

FIG. 10.—Case 1, visual fields charted 14 months after operation.

Case 2.—This patient, a 48-year-old single woman, was referred, in March, 1949, by Drs. W. J. Hope-Robertson and A. D. S. Whyte. For four months she had noted a slight but apparently progressive impairment of vision in her right eye. During the last two months she had found herself unable to thread a needle in poor light, and more recently she had become aware of a streak of darkness in the vision of her right eye, which was continuously present above and to the nasal side of the fixation-point. She was, however, still able to read a newspaper with either eye without spectacles.

A year previous to admission she had suddenly developed a severe headache in the right frontal region, which had lasted two days. Simultaneously she had noted a "black eye" on that side, as though she had been bruised, but there had been no injury. Since her vision had become impaired, further but milder attacks of frontal headache had occurred. Apart from an attack of jaundice during her late teens, previous illnesses had consisted only of childhood fevers. Since adolescence she had always been of large build. Her menses had been normal until three months previously, when they had become irregular and associated with menorrhagia. There was a history of rheumatism in her right wrist, but no history of thirst or polyuria. The family history seemed uneventful.

FIG. 11.—Case 2, general build.

FIG. 12.—Case 2, scalp incision on 14th post-operative day.

Examination.—A stout woman with a big skeletal frame, who was alert and of normal intelligence. Again the obesity was pronounced over the trunk and proximal portions of the limbs (Figs. 11 and 12). Height, 5 ft. 9 in. Weight, 18 st. There was marked hairiness of her legs and a masculine type of pubic hair distribution. There was no hirsuties of the face.

Ophthalmological Examination.—Visual acuity: right eye 6/9, J.1; left eye, 6/9, J.1. Both eyeballs were emmetropic, the intraocular tensions normal, and

the conducting media clear. In the right eye there was some pallor of the temporal half of the disk, but the retina and the retinal vessels were normal. The left fundus was entirely normal.

The visual field of the right eye showed a sector-shaped defect situated immediately above the horizontal meridian in the upper nasal quadrant, and reaching to the blind spot (Fig. 13). There was a smaller and less distinct

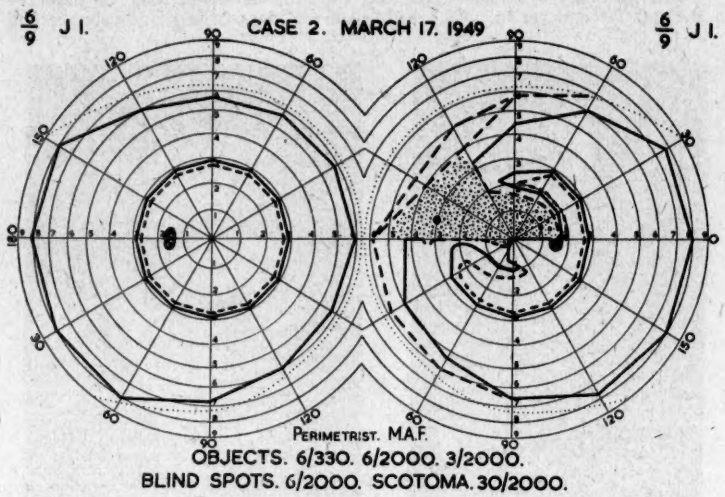

FIG. 13.—Case 2, visual fields charted before operation.

defect below the horizontal meridian. The appearances were those of a nerve-fibre bundle defect.

The left visual field was normal. The eyeball movements were full, and there was no squint or nystagmus. The pupils were equal and they reacted briskly to light and convergence.

Other systems.—No abnormality was detected during the examination of the nervous system, or of the heart and lungs (B.P. 150/100). Her joints were supple, and she had no goitre. The fluid balance was normal.

Radiological Examination.—Views of the skull showed a few broad-based osteophytes projecting from the inner table on either side of the superior longitudinal sinus in the frontal region (Fig. 14).

Views of the right optic canal showed a sharp spike 3 mm. high projecting into its lumen from the outer wall just below its horizontal equator (Fig. 15). The left optic canal was completely circular.

X rays of several joints and limb bones were also normal.

Laboratory Procedures:

(a) Basal metabolic rate—+9 to +11 per cent.

(b) Glucose tolerance test—normal, no glycosuria.

(c) Lumbar cerebrospinal fluid—normal.

(d) Blood count—normal.

(e) Blood sedimentation rate—36 mm. for first hour (normal 3 to 10 mm.).
(f) Serum calcium—8·5 mg. per 100 cc.
(g) Wasserman reaction—negative in blood.

FIG. 14.—Case 2, *X* ray of skull showing some broad-based osteophytes projecting intracranially in frontal reg on.

FIG. 15.—Case 2, *X* ray of right optic canal showing fine spike projecting into centre of canal from lateral wall just below the equator.

Summary.—The clinical picture in this patient presented many resemblances to that of the first patient. A diagnosis of glaucoma had been suggested by the visual-field changes, but had been ruled out by repeated observations of the intraocular tension, which had always been normal. Although the visual acuity of the right eye was still normal, the visual impairment was progressive, and, as in Case 1, the position of the visual-field defect corresponded nicely with the position of the spike within the optic canal. Furthermore, the same salient features of Morgagni's syndrome were present, although in different degree.

As Case 1 had benefited by decompression of the optic nerve, a similar operation was decided on to prevent further visual loss.

Operation.—A right frontal craniotomy was performed, similar to that in Case 1 (M.A.F.). In this patient, however, after the roof of the optic canal had been removed, the lateral wall was undermined on its outside, and then broken outwards in one piece away from the nerve (Fig. 16). The bony fragment thus obtained included the actual spike which had projected into the nerve (Fig. 17).

FIG. 16.—Case 2, post-operative *X* ray of optic canal indicating amount of bone removed. The location of the canal is completed with a series of white dots.

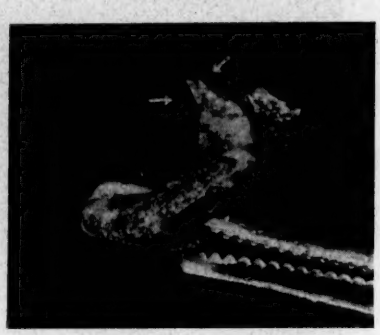

FIG. 17.—Case 2, bony fragment removed at operation from lateral wall of optic canal (×5·7).

Post-operative Course.—Convalescence was uneventful except that, for about two weeks, the patient had a ravenous appetite, without obvious excessive thirst. She was discharged from hospital on the seventeenth day, and about this time the scotomatous defect had lessened at the periphery of the field, and she was no longer aware of a streak of darkness in the vision of her right eye (Figs. 18 and 19).

Later Progress.—When seen again four months later, she stated that her vision remained good, and that she was aware of the dark streak only when tired. She had resumed her normal life. Dr. Hope-Robertson reported having observed an improvement in his visual-field charts from before operation similar to that shown by ours, but no further improvement of vision seemed to have occurred after the first month. Six months after operation the patient confirmed by letter that her vision remained improved.

Discussion

In both cases the evidence indicates that the visual failure was due to compression of the optic nerve by a bony spike. First we have the correlation in each case between the position of the visual-field defect and the position of the spike within the optic canal. Secondly, benefit followed surgical relief of the compression, for not only was the deterioration of vision halted, but in both cases a slight improvement in vision actually occurred.

Cases of failing vision due to concentric compression of an optic nerve within the optic canal have been described in such conditions as osteitis deformans, osteitis fibrosa, and leontiasis ossea,

where the optic canal may become involved in the bony disease (Falconer and Cope, 1942). One of us has recently reported a case, in which an optic nerve was compressed within the optic canal by a depressed spicule of bone projecting from a fracture

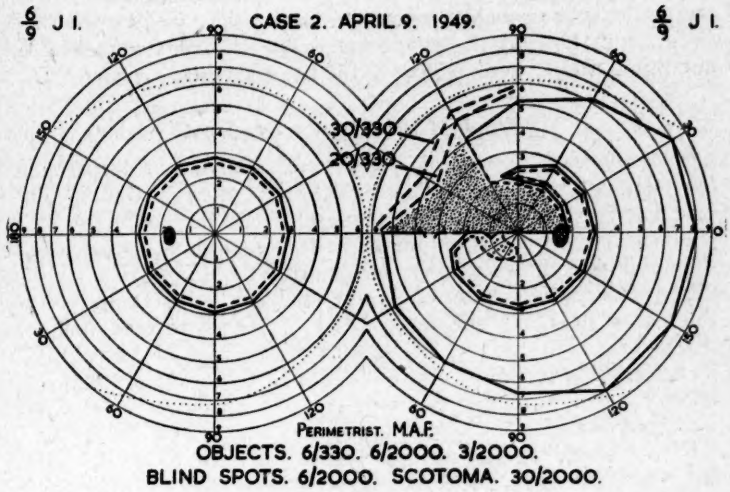

FIG. 18.—Case 2, visual fields charted 12 days after operation.

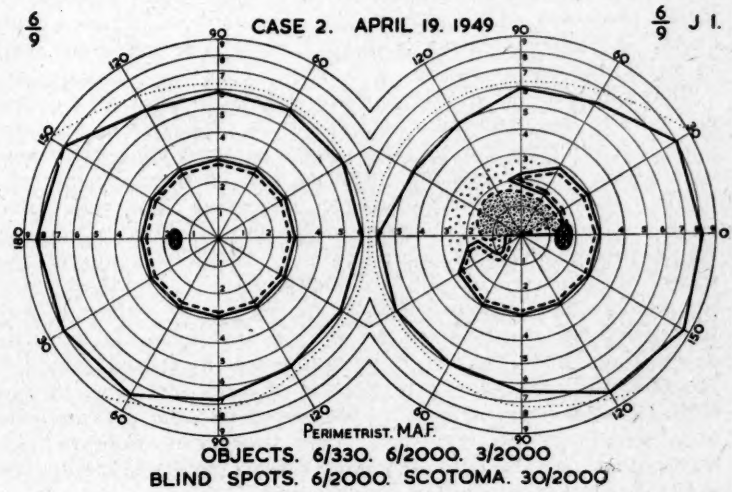

FIG. 19.—Case 2, visual fields charted 3 weeks after operation.

line; an improvement in vision followed decompression of the optic nerve (Falconer, 1949). A search of the literature, however, has failed to disclose any case-reports of optic-nerve compression by a bony spike developing *sui generis*, as in the two cases described in this paper. The development of the bony spikes in our two patients is probably accounted for by the fact that they both suffer from Morgagni's syndrome. The clinical features of this condition might here be conveniently reviewed.

Review of Morgagni's Syndrome

The triad of Morgagni's syndrome consists of hyperostosis frontalis interna, obesity, hirsuties; in some patients neuropsychiatric symptoms are also present. The aetiology of the condition is obscure, but most writers favour a disturbance of the hypothalamus-pituitary mechanism. Morgagni's original description, based upon a single case studied at autopsy, was published in 1765, but recognition of the syndrome has come mainly from the papers of Stewart (1928) and of Morel (1930). The condition is almost entirely confined to the female sex, about 98 per cent. of sufferers being women (Moore, 1935). It is uncommon under the age of 40 years, and occurs chiefly in the 50- to 60-year age-group. Statistics vary as to its frequency, but Pederson (1947) observed hyperostosis frontalis interna in 2 to 3 per cent. of skulls of 485 women *x*-rayed for head injury. Moore (1936) observed the condition in 1·44 per cent. of 6,650 skulls examined radiologically, but his material included both sexes. A higher incidence of this condition is probably met with in mental-hospital inmates.

Bony Changes.—These are chiefly confined to the frontal bone, and tend to be symmetrical. Osteophytes project from its inner table indenting the dura. They consist of dense cancellous bone covered by a layer of compact bone, and as development continues the diploe gradually becomes sclerosed. The outer table is never affected, and the contour of the skull remains unchanged. As the process advances, more and more osteophytes appear, and spread out fanwise from the falx and superior longitudinal sinus, the attachment of which is usually spared. Most authors appear to consider that, apart from the vertical and horizontal portions of the frontal bone, the rest of the skull is usually spared, although Moore (1935), recording a proportion of cases with seventh and eighth cranial nerve symptoms, suggested that the petrous bone may sometimes be involved. Our two cases indicate that osteophytes may also occur in the optic canal (sphenoid bone). The skeleton, outside the skull, is not involved.

Other Endocrine Disorders.—Obesity is seen in most cases. It involves mainly the trunk and proximal portions of the limbs, sparing the extremities, as it did in our two patients.

Hirsutism, rather than true virilism, is a prominent endocrine feature. It consists of an overgrowth of hair especially on the face, but without characteristic male hair-distribution, clitoral enlargement, or other stigmata of masculinization.

Menstrual disorders are common. Thyroid disorders are reported in about 5 per cent. of cases (Carr, 1936). Decreased sugar tolerance is not infrequent. Polydipsia, polyuria, and polyphagia were reported by Morel (1930), but are usually considered rare, although they were observed in our patients. Hypertension and arteriosclerosis seem to occur in a large proportion of cases.

Neuropsychiatric Symptoms.—These are often absent, but since the publication of the papers of Stewart (1928) and Morel (1928), both dealing with mental-hospital patients, a great deal of attention has been paid to nervous and mental manifestations. These may be merely frontal headaches, associated perhaps with memory defects and nervousness, but almost every form of psychosis, as well as epilepsy, has been encountered in or attributed to the syndrome, sometimes without adequate justification. Such features, apart from headache, were absent in our two cases.

Ophthalmological Aspects.—Few authors mention the question of visual failure in their case-material. Van Bogaert (1930), however, records a case of Morgagni's syndrome in which there was bilateral visual failure with optic atrophy; he presumed this to be due to pressure on the optic nerves within the optic canals, but the optic canals were evidently not demonstrated radiologically. Moore (1935) noted visual symptoms in thirteen out of 59 cases in which case-histories were available, but the tabulated summaries are insufficient for proper evaluation of the causes of visual failure. Moore, however, advised that detailed radiological studies of the skull, presumably including the optic canals (optic foramina), should be made in such cases, although he himself did not mention any specific instance. Carr (1936) mentioned a 41 per cent. incidence of visual symptoms, but did not amplify this statement. Since then several other authors have recorded in passing an occasional case with visual failure (Eisen, 1936; Andrews, 1942).

Conclusion

Our two patients thus presented all the requisite features of Morgagni's syndrome (hyperstosis frontalis interna, obesity, and hirsuties) although neither had obvious psychiatric disorders. They would appear to be the only cases of the syndrome at present recorded, in which the visual failure was shown to be due to compression of an optic nerve by a bony spike or osteophyte situated within the optic canal.

It seems likely that many cases of this condition must have been missed in the past, and consequently gone unrelieved. In skilled hands, the surgical decompression of the optic nerve should carry a negligible mortality, and should improve the prospects of sufferers with this condition.

Our two cases also illustrate the value of quantitative visual-field studies and of careful radiography of the optic canals (foramina) in all cases of failing vision, with or without optic atrophy, where the cause of visual failure is obscure (see also Falconer, 1949). The demonstration of a bony spike in the optic canal, the position of which can be correlated with the position of a progressive visual-field defect, is sufficient justification for surgical intervention. Our second case indicates that, if the best results are desired, such intervention should not be delayed until gross visual failure has occurred. The chances of restoring normal vision presumably become less the longer the compression has been in existence.

Summary

Two cases of unilateral visual failure are reported, both due to compression of an optic nerve by a bony spike situated within the optic canal. Both were benefited by decompressing the optic nerve, and, in one case, the bony spike was removed as well. In one instance the improvement of vision was from less than 6/60 to 6/9.

Both cases were examples of Morgagni's syndrome, and the salient features of this syndrome are outlined. The bony spikes within the optic canals had presumably a similar origin to the bony spikes or osteophytes arising elsewhere from the outer table of the skull.

A plea is made for early surgical intervention in similar cases in order to preserve vision. The value of quantitative perimetry and of careful radiography of the optic canals in the recognition of such cases is also stressed.

We are most grateful to our ophthalmological colleague, Dr. Rowland P. Wilson, for his assistance in both cases. In Case 1 the diagnosis of optic-nerve compression by a bony spike was first made by him, and he suggested that we should decompress the optic nerve. We are also grateful to Dr. A. C. Begg for the radiological studies, and to Mr. E. R. Macdonald for the reproductions.

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HAIDINGER'S BRUSHES AND THE RETINAL RECEPTORS*

With a Note on the Stiles-Crawford Effect

BY

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HAIDINGER (1844) described an entoptic phenomenon seen in plane polarized white light consisting of the appearance round the fixation point of yellow and blue " brushes " or " sheaves ", the yellow brushes being parallel to the plane of polarization of the light. This appearance was the subject of much speculation during the following years, and several explanations for the phenomenon were advanced; the explanation given by Helmholtz (1856) was generally accepted until it was questioned by Cogan (1941).

Theories formerly advanced

These are the major theories advanced to explain the appearance :—

I. That the brushes are due to multiple refractions at the boundary surfaces of the intra-ocular media.
II. That they are due to the intra-ocular media acting as doubly-refracting plates.
III. That they are due to radial fibres in the macular region acting as an analyser.
IV. That they are due to subtotal reflection of rays falling obliquely on the cones.

I. This theory, which was put forward by Erlach (1847) and Jamin (1848), was disproved by Helmholtz (1856), who showed that the brushes should, on this hypothesis, be centred along the optic axis, not the fixation axis, and also that they should become more marked towards the periphery of the retina, which is not the case. A further objection is that the brushes should appear almost equally distinct in all homogeneous colours, whereas they are most distinctly seen in blue light.

II. The theory that the brushes are due to the intra-ocular media acting as doubly refracting plates (Silbermann, 1846; Brewster, 1850) was recently revived by Cogan (1941). It is based on the fact that if a cornea or lens is placed between a polarizer and a crossed analyser, a black " cross " is seen, due to the doubly-refracting properties of the fibres and the structure (Stanworth and Naylor, 1950a). If a second doubly-refracting plate of appropriate retardation (presumably approximating to a wave

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plate) is then inserted between the polarizer and analyser the appearance can be changed to yellow and blue sectors which may bear a fairly close resemblance to Haidinger's brushes (Cogan, 1941).

Cogan, in his description of this theory, admits that he knows no structure in the eye that could act either as an interference plate or as an analyser. Silbermann (1846) postulated that the cornea and anterior part of the lens acted as the birefringent elements, and that the posterior part of the lens fibres, arranged radially, acted as the analyser, possibly assisted by some regular radial arrangement in the vitreous, whereas Brewster (1850) ascribed the analysing effect to the retina. However, an analyser with radially arranged elements would not produce the appearance of brushes for all positions of the original plane of polarization: what would be needed is an analyser in which all the elements were always crossed with the original plane of polarization, *i.e.*, an analyser which rotated with the rotation of the polarizer. It is difficult to imagine any intra-ocular structure which would do that. Brewster himself also pointed out the further difficulty that the directions of the blue and yellow brushes would always be at 45° to the plane of polarization of the polarizer and analyser, which is, of course, not the case. Another objection is that the centre of the brushes should appear red, as is shown in Cogan's picture of the interference figure, whereas this is, of course, not seen in the entoptic figure.

We have carried out further experiments which do not support this theory. If a small window is cut in the posterior part of the eyeball without disturbing the vitreous, and polarized light is allowed to enter the cornea and pupil, the emergent light can be observed through this window which is closed by a strain-free glass plate. The pupil then appears to be uniformly illuminated, showing that the cornea, lens, and vitreous do not contain any structures which act as an analyser. On Cogan's hypothesis, therefore, the postulated analyser must be in the retina. If a Nicol prism or piece of polaroid is used to represent this, the appearance shown overleaf in Fig. 1 is seen, projected into the pupillary area. This " cross " is analogous to that seen when the cornea alone is placed between a polarizer and crossed analyser (Stanworth and Naylor, 1950a). Light reaching the macula from that part of the pupillary area occupied by the dark cross must be polarized in its original direction: in addition, owing to the symmetry of the figure, the light from the remaining quadrants will not alter this state of plane polarization to any great extent. The macula will thus be uniformly illuminated by approximately plane polarized light, and will not be capable of appreciating the cross as such.

In addition, if plane polarized white light is passed through a

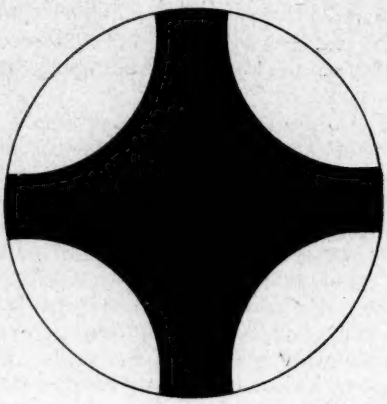

FIG. 1.

quarter-wave plate placed in a diagonal position to the polarizer, and is allowed to fall on a combination of a cornea and interference plate such as postulated by Cogan, the pattern seen is very different from Haidinger's brushes. It consists essentially of two red dots in opposite quadrants, as in Fig. 2, the arrangement of the other colours depending on the orientation of the quarter-wave plate relative to the interference plate. In practice, no such pattern is

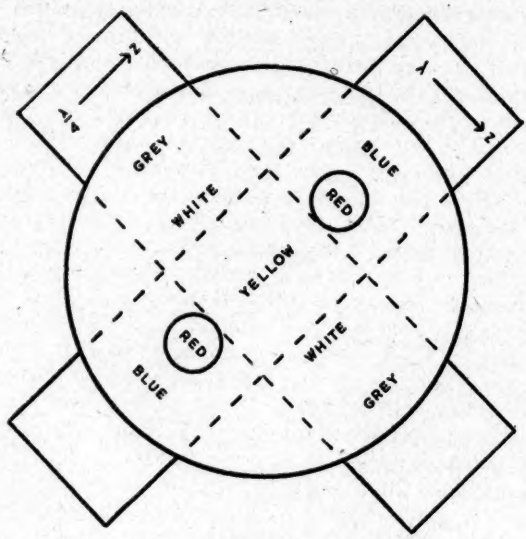

FIG. 2.

seen entoptically with a quarter-wave plate, the appearance of the brushes remaining substantially unaffected, though they are rather less easily seen. Under the same conditions in monochromatic light (so that circularly polarized light is produced), the appearance on Cogan's hypothesis should be of two dark dots in opposite quadrants. This again is not seen entoptically, for the brushes, if seen at all, retain their original form. In fact, Boehm (1940) has shown that all the entoptic phenomena induced by placing various interference plates between the polarizer and the eye can be explained by postulating that the brushes are always seen along the major and minor axes of the elliptical vibration produced, provided that the retina acts as a radial analyser and allowance is made for a retardation in the ocular media of about 50 mμ. The cause of this retardation has been discussed in another communication (Stanworth and Naylor, 1950a).

III. This hypothesis is that the brushes are due to a radial analyser, anterior to the rods and cones, which absorbs blue light to a greater degree when it is polarized in one direction (Helmholtz, 1856). Since the brushes are approximately equal in extent to the projection of macular area, the analysing action is usually taken to be due either to Henle's fibres or to Muller's fibres, both of which are radially arranged in this area. In order to explain the yellow colour of the darker brushes, Helmholtz assumed that in some manner the analyser strongly absorbs the extraordinary vibration for blue light (*i.e.*, it is dichroic). This would result in a sensation of yellow in the meridian in which this absorption is at a maximum. This blue-absorbing substance is often assumed to be the yellow pigment of the macula. The cause of the blue brushes is rarely discussed, but is usually taken to be due to contrast (Stokes, 1850).

To this theory several objections may be made:

(*a*) The yellow pigment is not associated with either Henle's fibres or Muller's fibres. In fact, it is distributed throughout the cerebral layers (Dimmer, 1907) and so is less plentiful in the fovea than in the peri-foveal region. On Helmholtz's theory the yellow brushes should, therefore, be either absent or much diminished in intensity at the fixation point, and in blue light the centre of the brushes should be light in colour. In fact, the centre is definitely seen to be dark, as are the originally yellow brushes.

(*b*) Though all nerve fibres are birefringent, there is no evidence that any of the radial elements of the macula are dichroic. Boehm (1940), though he supports Helmholtz's theory, states that if the isolated retina including the macular region is examined in polarized light, no brushes can be seen objectively, though they should be visible if the radial fibres of the macula are dichroic.

(*c*) On Helmholtz's hypothesis, the maximum absorption for blue would occur in the meridian parallel to the plane of polarization, and there would be a gradual decrease in the percentage absorption as the absorbing elements are more and more inclined to this meridian. Only in the meridian at right angles to the plane of polarization would no absorption occur, and so in all meridians except this, there should be an appearance of a yellow colour of varying intensity. In the model of a dichroic structure made by Boehm to correspond as far as possible with the radial fibres of the macula, yellow brushes are produced in white light, and dark grey brushes in blue light, but apparently nothing is seen corresponding to the blue or light sectors respectively. The uniformity in colour of the yellow brushes, and the existence of blue brushes, is thus unexplained.

(*d*) The blue brushes are not adequately explained by contrast. Their blue colour is not more marked at its border with the yellow, and their intensity is greater than would be expected from a contrast phenomenon. In addition, an object giving an image of the same size and colour as the yellow brushes does not produce such a contrast effect. We have also found that a negative after-image of the brushes is easily obtained, in which the positions of the brushes appear to be reversed. The blue brushes produce an after-image which is at least as vivid as that produced by the yellow brushes, which would not be expected if the blue brushes were merely contrast effects.

(*e*) We have also found that after five minutes' adaptation to blue light, the first brushes to appear are the blue ones, which would never occur if the only primary phenomenon was that producing the yellow brushes.

(*f*) It is believed by some observers that the yellow pigment of the macula is not present during life (Gullstrand, 1906). However, this objection is probably not valid, as the pigment can be seen by ophthalmoscopy, using almost, but not completely, red-free light (Thorner, 1932). If the macula is examined in red-free polarized light, one might expect on Helmholtz's theory that the yellow appearance would be most marked in the meridian parallel to the plane of polarization. Unfortunately, under these conditions, we have not been able to see the macula sufficiently distinctly to reach a definite conclusion.

(*g*) Gullstrand (1906) found that he could not obtain parallax between the peripheral parts of the brushes and the macula when using a pinhole, and concluded from this that the site of origin of the brushes must be in the sensory epithelium layer, and not in Muller's fibre layer.

IV. As we have seen, Gullstrand thought the origin of the brushes to be in the layer of sensory epithelium: he postulated

that it was connected with loss of light due to subtotal reflection occurring in those rays falling obliquely on the cones. The amount of this loss would be affected both by the plane of polarization and by the wavelength of the incident light.

One objection to this theory is that Barany (1946) has, as we shall see later, failed to find any such influence of the plane of polarization in the sensation of brightness from oblique rays falling on the retina. In addition, though the details of Gullstrand's theory are not very well worked out, this hypothesis, like that of Helmholtz, leads to the deduction that the brushes would appear to be of one colour only, the brightness alone varying in different meridians. The colours observed, therefore, are not explained.

New Theory

It would appear, then, that previous theories are scarcely satisfactory. Any theory must, to be adequate, explain the existence of the blue brushes as a positive phenomenon, and should fit in with modern knowledge of the birefringence and dichroism of the retina. The following points are of importance :-

(1) In the retina, the rods, cones, and nerve fibres are birefringent, but the only strongly dichroic structures are the unbleached rods (Schmidt, 1935).

(2) The blue receptors may be rods, or something intermediate between rods and cones (Willmer, 1946; Granit, 1947).

(3) It is the electric vector which is usually considered to be responsible for initiating photochemical changes (Houston, 1938).

(4) The light reaching the macula is, as we have already shown, substantially polarized in its original direction.

In view of these factors, it is suggested that the structures concerned in analysing the light falling on the retina are the blue receptors, which could be dichroic owing to a regular arrangement of the molecules of the " blue substance," similar to that of the molecules of the visual purple in the dichroic rods. It is postulated that this dicroic pigment is so united with the structure of the receptors that the latter are in some way orientated radially in the macula. The blue receptors which are lying in the direction of the electric vector would then strongly absorb the incident blue light. This absorption would be greater than the average absorption by the randomly arranged blue receptors in the peripheral field: consequently a sensation of blue would be produced. The light would, however, be only weakly absorbed by the blue receptors lying perpendicular to the electric vector, and consequently the preponderance of stimulation of the remaining retinal receptors would result in the complementary sensation of yellow. The fact that both the yellow and blue brushes are positive phenomena is thereby explained. On this theory as it stands, the mid-lines of

the yellow and blue brushes should present the deepest colour, which should fade away to white at the boundary between the brushes. At this boundary, however, simultaneous contrast would be expected to reinforce the colour on either side, and might well produce the uniform yellow and blue brushes seen.

This hypothesis has thus many advantages over that of Helmholtz; there are, however, two possible objections:

(1) The fovea itself may be blue-blind (Willmer and Wright, 1945) and consequently unable to take part in these suggested phenomena. It may well be, however, that the central blue-blind area, which in normal use of the eyes is not seen as such (owing, possibly, to physiological filling-in of the blue scotoma and the slight ocular movements) will be perceived when it is flanked closely on each side by a yellow sensation. In this case the yellow sensation would include the fovea, as is the case with the brushes.

FIG. 3.

(2) For light passing along their axes, the unbleached rods are not dichroic, but absorb light polarized in all meridians (Schmidt, 1935). In order to exhibit dichroism, the light must pass across the length of the rod and, presumably, of the blue receptors also. It must be remembered, however, that in all probability light falling normally on the retina does not pass directly along the axis of the receptor. A hypothetical diagram of the structure of a cone and of the pathway of light through it, similar to that given by O'Brien (1947) is shown in Fig. 3, where it will be seen that light is internally reflected in the cone ellipsoid BC and passes obliquely, with several more internal reflections, through the outer member CD; during this passage the postulated dichroic action could take effect.

The fact that the light from the peripheral part of the pupil must fall obliquely on the receptors gives rise to the idea of a second possible mechanism whereby the dichroic action could occur. In this case it might be expected that the brushes would be seen more clearly with a dilated pupil, but if the mechanism described above is adequate, the extra absorption from the increased obliquity might be inappreciable. Also the larger effective birefringence of the more peripheral parts

of the cornea and lens would tend to obscure the simple polarization of the light falling on the retina and so to decrease the clarity of the brushes. In fact, we have been unable to be certain of any alteration in clarity with a dilated pupil.

One further point of interest is that the rate of adaptation of the blue receptors may be greater than that of the other receptors (Wright, 1934; Granit, 1947). In view of this, after adaptation to white light, it might be expected that the blue brushes would appear first. Unfortunately, the speed at which the brushes appear under these conditions is so rapid that it is difficult to be certain whether or not this is so.

Summary

1. Previous explanations of Haidinger's brushes are discussed.

2. A new theory is advanced that they are due to postulated dichroic properties of the blue receptors of the macula.

A NOTE ON THE STILES-CRAWFORD EFFECT

The directional sensitivity of the retina described by Stiles and Crawford (1933) in which the sensation of brightness produced by light entering the periphery of the pupil is much less than that produced by the same light entering centrally, was ascribed by Wright and Nelson (1936) to the transition from sub-total reflection to total reflection in the light-percipient elements of the retina in these circumstances. Barany (1946) attempted to test this theory by using polarized light, on the basis that in sub-total reflection the relationship between the energy of the refracted and reflected rays depends on the plane of polarization of the incident light, and hence, on the theory of Wright and Nelson, the intensity of stimulation should also depend on the plane of polarization. He could not find any such variation, however, and concluded that his negative results argue against Wright and Nelson's theory, though they do not definitely disprove it, since it is not known how large the anticipated effect would be if the theory were correct. The theoretical basis of the experiment was also further discussed by O'Brien (1946; 1947) and Platt (1947).

In these discussions, however, no account was taken of the effect produced upon the plane of polarization by the birefringence of the cornea and lens. We have already shown in the discussion of Haidinger's brushes that if the whole pupillary area is illuminated the light reaching the macula is still substantially polarized in its original direction. If, on the other hand, in an eye with the posterior scleral window described above, a thin pencil of plane polarized light is allowed to enter the pupillary area at a point

which is not situated on the interference figure, it will be found that the crossed analyser does not completely extinguish the emergent light, showing that the plane of polarization has not remained unchanged. For a pencil of light entering the pupil at any point on the interference figure (which includes the centre of the pupil) the light is almost completely extinguished by such an analyser and therefore the plane of polarization has remained substantially unaltered. If the polarizer and analyser are rotated together the interference figure is seen to rotate with them, and any point near the periphery of the pupillary area lies on the interference figure four times in each complete revolution.

Under the conditions of Barany's experiment, in which the polarizer is rotated at a speed of 2-10 revolutions per second, the light reaching the retina should, therefore, be polarized in its original direction four times per revolution. For all other directions of the polarizer its state of polarization will depend on the magnitude of the birefringence of the cornea and lens, which will lead, in general, to some form of elliptical polarization.

It is impossible to calculate with any accuracy the effect that this elliptically polarized light will have on the quantity of light lost by sub-total reflection, since the conditions both of the light itself and of the retinal structures are not known with any certainty. It can be said, however, that the expected variation in the sensation of brightness produced by the type of variable polarization described above will never be greater than that postulated by Barany on the original supposition that the light reaches the retina plane polarized; in fact, it is most likely that it will be less.

It appears then that consideration of the effects of the birefringence of the ocular media supports the view that the negative results obtained by Barany do not exclude the explanation of the Stiles-Crawford effect advanced by Wright and Nelson.

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THE EXPLORATION OF THE ORBIT *

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THE PRESENCE of space-taking lesions in the orbit can be diagnosed with a fair degree of confidence, but difficulty frequently arises in determining the nature, the size, and the exact position of such tumours. Those near the outlet of the orbit and those outside the periorbita do not usually present this difficulty; but when surgery is required for deeper tumours in the intermediate space and in the muscle cone, the operation is to some extent an exploratory procedure. It should, therefore, be planned so that it can be adapted to deal with any condition that is found. It is usual to employ for these cases a sub-periorbital approach, following either a Kronlein osteoplastic resection or an incision down to the margin of the orbit. The transconjunctival route, advocated by Reese and others, is rarely employed, despite certain advantages, as it is generally assumed that it does not provide a satisfactory exposure of the larger tumours. In order to determine the validity of this assumption and define the limitations of this form of exploration of the orbit, the technique described below was employed for eight consecutive cases, seven of which were found to have intra-orbital tumours.

The following modification of the transconjunctival approach is designed to provide access to all parts of the orbital cavity by displacing the eye after detaching such fascia and muscles as necessary. A free lateral canthotomy is carried out down to the orbital margin and the lateral palpebral ligament and the palpebral fascia are freed from their attachment to the periosteum. The horizontal incision in the conjunctiva is extended upwards or downwards, depending on the estimated position of the tumour, keeping a few millimetres to the bulbar side of the fornix. If the inner side of the orbit is to be explored, this incision is continued round to the internal rectus. Digital palpation through the incision now enables the contents of the muscle cone and the intermediate space to be examined.

If the tumour is palpated in the cone, the external rectus is cut between sutures, the eye fully adducted, and the contents of the muscle cone exposed. If the tumour is found to be in the intermediate space, the conjunctival incision is extended as required. The tumour is localized by palpation and mobilized by blunt

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dissection. Where necessary more room is obtained by section of the recti and displacement of the eye.

Careful adjustment of the muscles and suture of the conjunctiva and skin are required when the removal of the tumour is completed to secure a satisfactory post-operative position of the eye and to preserve the conjunctival cul-de-sac. Two months after operation it may be necessary to correct any residual deviation.

When, as in Cases 2 and 3, the tumour is found attached to the eye, this operation allows enucleation to be carried out without the disturbance of periorbita and intra-orbital fat created by the sub-periosteal approaches, thereby leaving a better socket and involving less surgical trauma.

In only one case (No. 8) was resection of bone found necessary. This very vascular tumour extended into the apex of the orbit, and it was considered desirable to secure more room to control the entering vessels. In such rare cases displacement of the wall of the orbit can be carried out by extending the skin incision by two cuts along the orbital margin, making it into a horizontal Y shape. An osteoplastic resection can then be carried out, giving a better exposure than the classical Kronlein method, which leaves a bridge of skin and tissue between the displaced bone and the eye.

When, as in Cases 4 and 7, the exploration shows an exenteration to be advisable, this can be carried out more satisfactorily than by the Kronlein or other sub-periosteal approaches, for the periorbita has not been disturbed. The instruments are changed, an incision is made peripheral to the original incision, and the contents of the orbit are removed in an intact sac of periosteum.

Case 1.—This man gave a history of a sensation of pressure on the left eye and recurrent attacks of oedema of the upper lid which had persisted for over

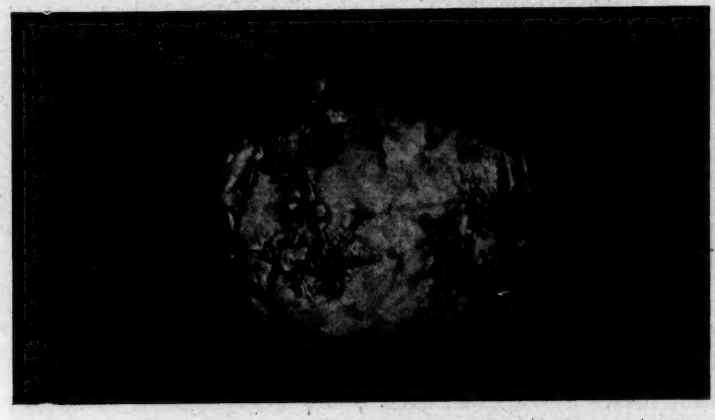

FIG. 1.—Case 1, mixed tumour of the lacrimal gland. (1·2 × 1·5 × 1·5 cm.)

three years. The left vision was 6/5, no diplopia or limitation of movement could be detected, and clinical investigations revealed no abnormality. Some six months later after another attack of oedema, it was possible to palpate, beneath the rim of the orbit, what was assumed to be a tumour of the lacrimal gland. The gland was exposed by the technique under review and the tumour removed.

Extract from Pathological Report.—A mixed-celled tumour of the lacrimal gland, 1·2 x 1·5 x 1·5 cm. Completely removed.

Such a tumour could have been removed through an incision below the brow, but before exposure there was no assurance that one was dealing with a relatively benign encapsulated mass. Had this not been the case, the approach used would have enabled other tumours in this area with possible extensions deep into the orbit to have been treated. Moreover, the transconjunctival approach leaves a smaller scar, and a few weeks after the operation there was little evidence of an operation having been performed.

Case 2.—A history of proptosis of the left eye for nine years was given. The eye had no perception of light; pupil inactive to direct, active to consensual stimulation, movements equally limited in all directions with a proptosis straight forwards. There was papilloedema, and a diagnosis of optic neuro-fibroma appeared probable. Clinical investigations revealed nothing abnormal except a strongly positive Wassermann reaction. Treatment for the latter carried out for eighteen months led to no improvement in the proptosis, which was, in fact, considered to have increased. Exploration of the orbit was therefore carried out. The method under review gave perfect access to contents of the muscle cone after cutting the external rectus, and a tumour of the optic nerve was exposed. It was found to merge with the sclera anteriorly, making it impossible to separate the eye. The conjunctival incision was, therefore, continued around the eye and an enucleation carried out, cutting the nerve well back behind the growth.

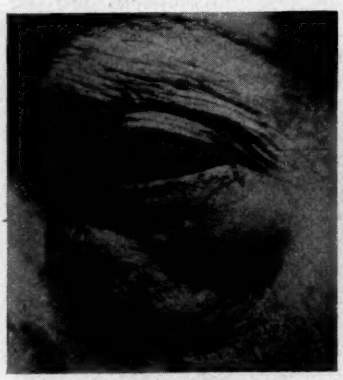

FIG. 2.—Case 2, showing left proptosis.

FIG. 3.—Case 2, meningioma of the optic nerve (2·5 × 2·8 × 2·2 cm.)

Extract from Pathological Report.—Situated around the optic nerve is a dome-shaped tumour of 2·5 x 2·8 x 2·2 cm., its base in close relationship to the sclera. Meningioma of the optic nerve.

Conditions such as in this and the next case, which involve sacrificing the eye, can be dealt with as a simple enucleation, and surgery of the bony orbital wall is redundant. The approach under review enables the position to be recognized and the enucleation to be carried out without preliminary damage to the bone, periorbita, and intra-orbital fat. This technique, therefore, gives less operative trauma, a much more satisfactory socket for a prosthesis, less disfigurement, and a shorter convalescence than will result from a preliminary osteo-plastic resection.

Case 3.—A history of an operation for detached retina in the left eye nine years ago followed by gradual loss of sight was given. The previous day swelling and pain had commenced. On examination, a left proptosis and oedema of the lids were found to be present. There was no perception of light, the tension was raised, the anterior chamber shallow and the lens pushed forward and opaque. The sudden onset was suggestive of a haemorrhage but the history made it necessary to consider the possible presence of a choroidal sarcoma. Clinical investigations revealed no relevant abnormalities and the orbit was exposed by the method under review. When the muscle cone was opened a large posterior staphyloma was found, suggestive of an intra-ocular tumour commencing to perforate the sclera. The contents of the muscle cone were examined and a small nodule found lying on the optic nerve, otherwise the orbital contents appeared unaffected. The question was whether these findings justified continuing the operation as an exenteration of the orbit, as in the next case, or whether a free removal of the eye, optic nerve, and contents of the muscle cone would meet the case. The latter course was adopted.

FIG. 4.—Case 3, showing left proptosis.

FIG. 5.—Case 3, malignant melanoma of the choroid. Extra-ocular extension.

Extract from Pathological Report.—Situated in the posterior half of the globe there is a necrotic, spindle-celled, heavily pigmented, malignant melanoma of the choroid. The growth has invaded and penetrated the sclera forming a nodule externally.

The approach used enabled a thorough study of the contents of the muscle cone to be undertaken without the additional, and in such cases unnecessary trauma, involved by a bone resection. When a new growth suspected of being malignant is discovered, this technique confines the preliminary surgery to within the periorbita and eliminates the risk of implanting tumour cells outside this membrane. If exenteration is found to be indicated it can, therefore, be carried out with the benefit of an intact periorbita. Alternatively, if more conservative surgery and post-operative radio-therapy is considered adequate, a more presentable socket will result than that following a preliminary exploration by the Kronlein-Wagner technique.

Case 4.—One year previously had been under treatment for malignant cervical glands on the right side, which subsided with radiotherapy. No primary growth was found. Some right proptosis, oedema of the lids, and pain had recently developed, vision had fallen to perception of light, and papilloedema was present. Clinical investigations revealed nothing significant. The technique under review

FIG. 6.—Case 4, showing right proptosis.

was used for exploratory purposes and the apex and posterior third of the orbit were found to be filled by new growth. The instruments in use were discarded and an exenteration of the orbit leaving the lids was carried out through a conjunctival incision peripheral to the one used for the exploration.

Extract from Pathological Report. — Lympho-epithelioma probably extending from the nasal cavity or naso-pharynx, anaplastic carcinoma.

The use of the Kronlein approach in such a case would involve an incision being made through the periorbita into a cavity containing a malignant growth. The sub-periosteal space is, therefore, liable to contamination and the virtue of an exenteration —the removal of the orbital contents in an intact sac of periosteum —is lost. The technique under review allows the exploration to be carried out within the confines of the periosteum and, if malignancy is found, the instruments can be changed and a more efficient exenteration can be performed than after the Kronlein approach.

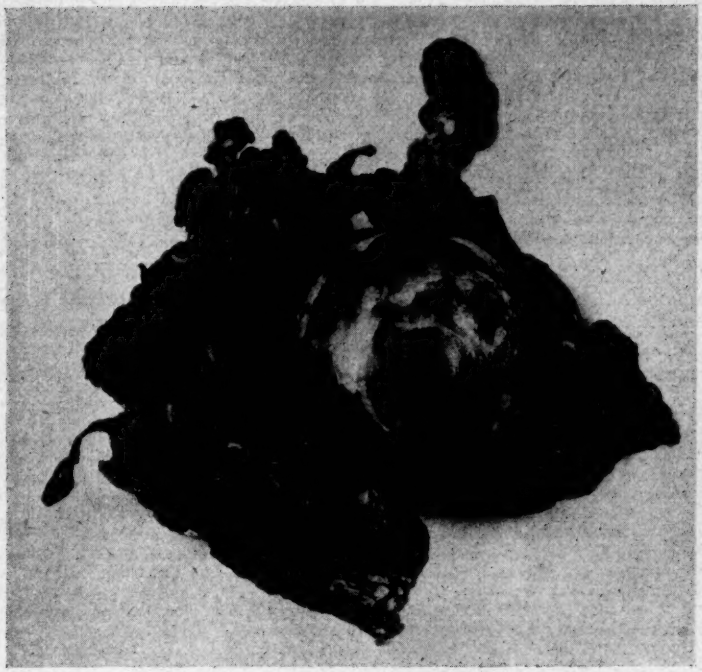

FIG. 7.—Case 4, anaplastic carcinoma of the nasal cavity. Orbital invasion.

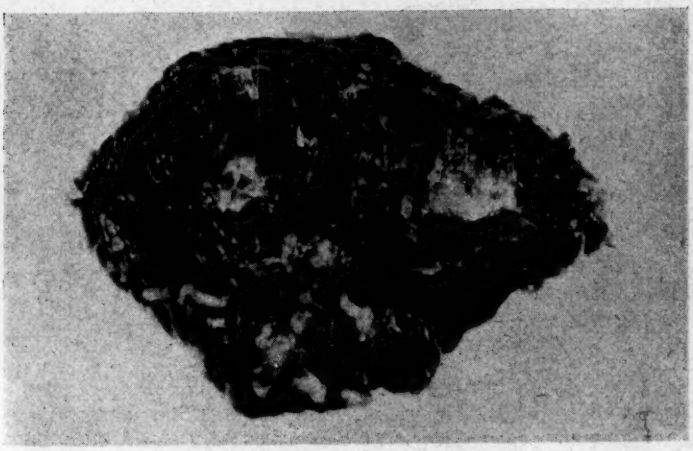

FIG. 8.—Case 5, pseudo-tumour of the orbit. ? Tuberculoma. (4·3×3·1×3 cm.)

Case 5.—A history was given of discomfort around the left eye and diplopia of recent origin. An ill-defined irregularity within the medial extremity of the left inferior orbital margin was palpable. Clinical investigation revealed no material abnormalities. The tumour and the limitation of movement rapidly increased. Exploration by the method under review exposed a large tumour occupying the medial two-thirds of the floor of the orbit, extending behind the eye and enclosing the inferior rectus and oblique, the medial rectus, and the optic nerve. The exposure provided by the transconjunctival approach permitted a satisfactory dissection and complete removal, without removal of the eye (Fig. 8).

Extract from Pathological Report.—The tumour consists of dense fibrous tissue infiltrated with chronic inflammatory cells. Throughout there are aggregations of lymphocytes around small blood vessels and an occasional giant cell may be seen.

This exceptionally large tumour, most of it in the medial half of the orbit, was mobilized and removed without difficulty by lateral canthotomy and a conjunctival incision. Resection of the lateral orbital wall would have given no more space and would have added to the severity of the operation and the post-operative disfigurement.

Case 6.—This patient had a seven-years' history of right proptosis and some limitation of movement. The condition had been stationary and was considered to be due to a partial third nerve paralysis resulting from a cerebral abscess. During the past year she had complained of discomfort and pressure on the right eye, and she considered that the proptosis was increasing. No objective evidence of this could be found, but owing to her insistence it was considered advisable to explore the orbit. This was carried out by the technique under review. The external and superior recti were cut and this provided a sufficiently satisfactory exposure to confirm the absence of any intra-orbital tumour. The opportunity was taken of shortening the superior rectus, and the final result was an improvement in the patient's appearance as the result of the exploratory operation instead of any disfigurement.

FIG 9.—Case 6, showing right proptosis.

The technique under review is particularly valuable when no tumour is believed to be present but confirmation of the opinion is considered desirable. Less hesitation need be felt in under-

taking the exploration by a method involving so little surgical trauma and also giving the opportunity, as in this case, of improving the appearance of the patient by muscle surgery.

Case 7.—This patient had had both breasts removed five years previously owing to carcinoma and was reported to have multiple secondary deposits. Nodules could be palpated within the lower orbital margin consisting presumably of orbital metastases. In view of the hopeless prognosis, no surgery was at first considered desirable. But representations were made by her doctor for the orbital growth to be removed if possible, as she was being kept in ignorance of the recurrence of the disease and the gradually increasing proptosis and the discomfort were making her very unhappy. As her general health was still fairly good, it was considered under these circumstances that the removal of the orbital growth was justifiable. As the prognosis was hopeless and the object was only to give temporary comfort and to improve her appearance, a complete exenteration was undesirable. The technique under review was employed to study the extent of the new growth and it exposed a flat white plaque occupying the lateral half of the floor of the orbit. The tumour, the periorbita of the lateral two-thirds of the orbit, the eye, the superior, inferior and lateral recti, and the inferior oblique were removed. Sufficient conjunctiva was retained to cover the bare bone and a socket capable of retaining a prosthesis was obtained after three weeks. It was later reported that the patient survived for five months and that she was not bothered by pain in the orbit until too late in the illness to cause her much concern.

Extract from Pathological Report.—Metastatic carcinoma with much necrosis in places.

This partial exenteration was undertaken merely to give temporary symptomatic relief while avoiding gross disfigurement. This approach enabled the orbit to be examined and an estimate reached of the tissues to be conserved, more satisfactorily than by any other exploratory technique.

Case 8.—A history was given of a gradually increasing left proptosis for seventeen years. The left eye was so proptosed as to be nearly dislocated and the

FIG. 10.—Case 8, showing left proptosis.

conjunctiva and lids were oedematous. Investigation revealed no relevant abnormalities. Exploration was undertaken by the method under review. A cavernous haemangioma was found to occupy the whole of the orbit except the infero-nasal quadrant. The orbital fat was absorbed and replaced by new growth which extended right to the apex. The exposure given by the technique under consideration allowed the tumour to be defined and dissected free from the eye and orbital walls, after resection of the external and inferior recti. In view of the danger of haemorrhage from blind dissection at the apex of the orbit which was completely occupied by growth, it was considered desirable to get better access to the posterior aspect of the tumour by displacing the lateral orbital wall. The technique in use enabled this to be conveniently carried out, and as this still did not give sufficient exposure, the bone was temporarily removed. The tumour was then removed and the lateral wall replaced. The eye was retained.

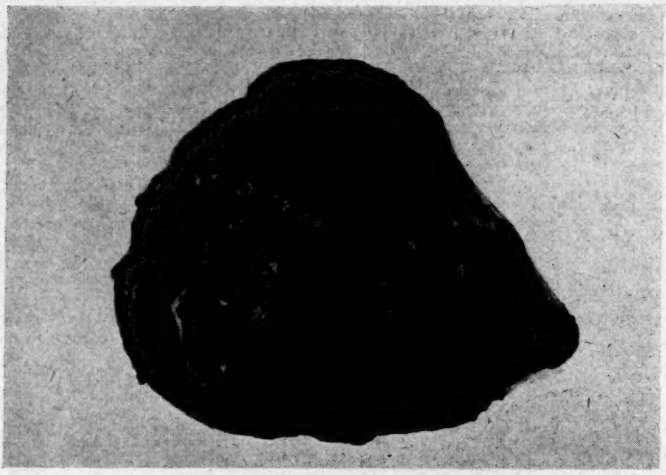

FIG. 11.—Case 8, cavernous haemangioma. (3·6×2·7×3 cm.)

Extract from Pathological Report.—Wedge-shaped, reddish tumour 3·6 x 2·7 x 3 cm. On section it contains many minute spaces filled with blood. A cavernous haemangioma with evidence of old haemorrhages. There is no evidence of malignancy. The tumour appears to have been completely removed.

This was the only tumour in the series requiring bone resection, and then rather because of the necessity of controlling a potential haemorrhage than because of its size. It was an exceptionally large tumour occupying nearly all the retrobulbar space, and the fact that it could be mobilized without bone resection suggests that the exposure given by the method under review should be adequate for the majority of tumours.

Conclusions

Unless the pre-operative investigations indicate the desirability of some specific form of orbitotomy, it appears that a trans-conjunctival approach combined with a free canthotomy provides a satisfactory method of exposing the orbit and dealing with any lesion found. It satisfies the three main requirements of such an operation.

(1) Adequate access is provided to every part of the orbit. Pre-operative investigations may localize the main mass of a tumour, but an operation giving an adequate exposure of any offshoots is essential, for incomplete removal of some benign tumours predisposes to a recurrence, which is occasionally malignant. An example was Case 5, who appeared to have only a small tumour lying on the medial part of the floor of the orbit near the opening. But at operation this was found to extend well backwards behind the eye, to embrace the optic nerve, and to measure $4{\cdot}3 \times 3{\cdot}1 \times 3$ cm. Despite the retrobulbar extension, it was completely removed by the transconjunctival approach; the Kronlein method would have added to the operative trauma and given no better access, while the approach through an incision in the lower lid would have provided a totally inadequate exposure.

(2) The object of the operation is secured with minimal disfigurement and surgical trauma. Any orbit containing a tumour of doubtful pathology should be explored, but if the operation involves much operative risk or facial disfigurement there is a temptation to temporize in some cases. An example was Case 3, who suddenly developed a left proptosis, pain, and oedema of the lids, with an increased ocular tension in an old blind eye. The clinical picture was not pathognomonic of malignant disease of the orbit and some delay might have been justifiable if this had involved a major procedure. Another example was Case 6, complaining of an increase of an old-standing proptosis and discomfort for which there was no objective evidence. One suspected that an anxiety state rather than a tumour was the cause of the symptoms and one would have hesitated to undertake any exploration which involved any risk of disfigurement. As the technique described involves little trauma or post-operative deformity, exploration in such cases can be carried out immediately clinical investigations fail to identify the nature of the condition.

(3) The surgical approach should be one which does not jeopardize the efficient performance of any further procedure made necessary by the condition discovered. In this respect a trans-conjunctival approach to the orbit is preferable to other methods. Small encapsulated intra-orbital tumours can be removed with a minimum of trauma, and the conjunctival incision can be extended,

and the muscles resected as required, to give access to every part of the orbit and to deal with any other condition. If bony resection be found necessary, it can be done by extending the skin incision. More important is the fact that with this approach no incision is made through the periorbita. As a result, if the exploration reveals malignant disease, the instruments can be changed and the contents of the orbit exenterated in an intact periosteal sac.

The author wishes to express his thanks to Dr. Charles Swan and Dr. Norman Ashton of the Institute of Ophthalmology, London, for their detailed pathological reports.

A CLINICAL STUDY OF DIABETIC RETINAL ANGIOPATHY

BY

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THE purpose of this paper is a limited clinical study of the type of diabetic patient who develops a retinal angiopathy, and of the possible mechanism of this development. It is limited by methods of examination—clinical only, by the instruments employed, by the number of patients investigated, by omission of many possible tests, such as fields of vision, acuity of vision, scotomata, etc., but it is believed that some light will be thrown on this puzzling problem and it is hoped that the attention of some investigators more happily situated than the writer will be drawn to newly elicited facts. From the very extensive literature in existence only a few quotations will be given.

The second question that will be examined is the well-known fact that the prognosis as regards life is not bad, but for vision, very gloomy. The retina may be almost completely destroyed, but the patient may be mentally alert.

Methods

Systolic Pressure (MX of the French writers).—The measurement was done on the wrist by palpation with the original Pachon's cuff (not that of Gallaverdin). The distension of the arteries due to the passage of the pulse wave is never seen in the retina, and the arteries there never collapse. This is due to the buffer action to the intra-ocular tension plus the peculiarity of the venous outflow of the retina. But this distension is clearly demonstrated in the limbs by the oscillometric method of Pachon.

For the purpose of this paper I selected the following groups of cases: five normal persons as controls, five with mild essential hyperpiesis (diastolic pressure 90-100), five with advanced essential hyperpiesis (diastolic pressure 100-150), and forty diabetics, of which fourteen had a retinopathy.

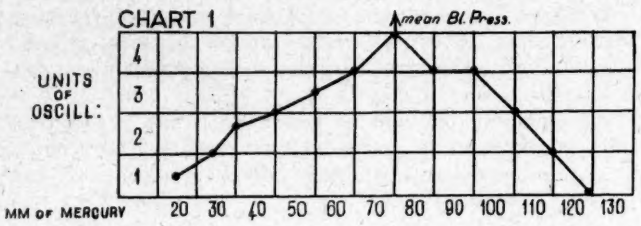
It seems, from the Table (p. 312), that the highest systolic blood pressure (average) was in the third group, where no retinopathy of any kind was seen. However, in the diabetic group the average systolic pressure for both wrists was 170½, and the retinopathic group, actually lower, 163½. This seems to justify the emphatic remark of Koyanagi (1935) " il faut donc abandonner l'axiome :—

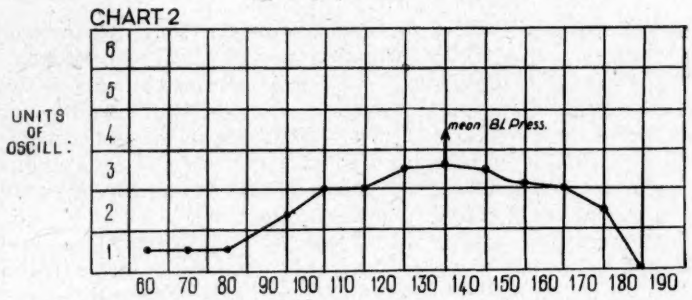
* Received for publication October 25, 1948.

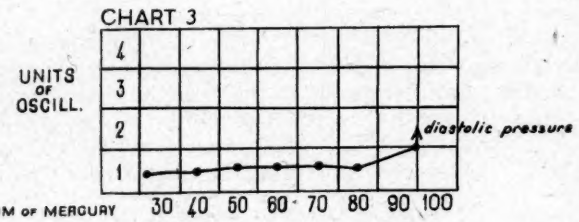
pas de rétinite diabétique sans hypertension." Folk and Sosskin share the same opinion, although the problem in my view is much more complicated.

Mean Blood Pressure (press. efficace).—This is an item of more importance than any other. While the systolic (MX) and diastolic (Mn) are correspondingly the highest and lowest level of pressure inside the arteries—the mean is the constant one that continuously forces the blood from the arteries into arterioles, capillaries, and veins. It can be measured *only* by using an oscillometer, and so building up an oscillometer curve.

The figures obtained vary with each individual patient, and in each limb of that patient. The mean pressure may form a high point or a plateau; in the latter case the line passing through the







middle point will be the mean pressure. The following charts will illustrate it, the ordinates being the units of oscillometry and the abscissae the corresponding readings of blood pressure in mm. of mercury (oscillometer of Boullite—Paris).

The mean pressure corresponds, as is seen in Charts 2 and 3, to the range of maximum oscillation. The height of this mean pressure, *ceteris paribus*, is the best indication of the state of the peripheral vascular resistance due to tonic (not spasmodic) contraction of the muscular media. Many authorities think that it is simply half of the pulse pressure (Best and Taylor, 1939; Macleod, 1938; Norris and others, 1927). It is nothing of the kind. Moreover, it may fluctuate independently (or nearly so) from both systolic and diastolic pressures. In one of my diabetics, a male aged 70 years, the reading was 160/90, mean 110, on May 31, 1948; on August 16, 1948, it was 180/80, mean 155; fundi were the same on both dates—meaning that the peripheral vascular resistance was on the increase.

Bailliart's method, in my opinion, is as necessary to a complete clinical picture as the measurement of the three blood pressures on the brachial or radial artery, and is as reliable. In this investigation one sees at first a faint tremor of the central artery on the disk, followed by pulsation—in the words of Duke-Elder, " the blood column flushes across the disk " (1940). It is obvious that the beginning of this pulsation is the measure of the mean pressure, not of the diastolic—which is evidenced by the tremor—because the mean pressure must be overcome before the artery collapses. Fritz (1946) thinks that the difference of the two applied pressures is the measurement of the rigidity of the muscular wall of the central artery. It is only partially so, because the difference between the diastolic and mean blood pressure is probably due to many factors, not well known at present. But whatever pressure will be applied on the eye-ball, it will never collapse the arteries on the retina even in the neighbourhood of the disk. This is why I cannot entirely agree with the opinion of Fritz that the cessation of the venous pulsation means the collapse of the retinal capillary tension—it is only partially true on retinal venous pulsation; see Pines (1948). The Table compares the mean blood pressure in the five groups.

Certain observations are rather interesting at this point. The 10 mm. difference in mean-pressure in normal persons is probably due to the action of the vasomotor system. No difference was observed in both groups of hyperpietics. In diabetics the difference is approximately equal (5 and $2\frac{1}{2}$) in both females and males, but is rather large in the average taken of retinopathic results, eleven in males and even fifteen in the females. This result points to disturbance of elasticity.

Diastolic Pressure.—There is no general agreement on what is the level of diastolic pressure. The best summary is contained in the joint report of the Cardiac Society of Great Britain and of the American Heart Association (1939). While the British society considers the change from a clear to a muffled sound as the level of the diastolic pressure, the American committee recommends that if there is a difference between this point (change to the dull sound) and the level at which sounds disappear completely, the latter reading should also be regarded as a measure of diastolic pressure (*e.g.*, 80-70). I therefore relied only on oscillometry. Diastolic pressure is easily measured by the first larger oscillation, followed by a still larger one, thus forming a definite steep ladder in the curve if the measurement starts from zero, and *vice versa* if it starts from the systolic reading.

MacWilliam and Melvin (1914) say that "the Pachon and Diastolic index represented by the level of the armlet pressure immediately after declension, corresponded with remarkable exactness with the weakening and dulling of the sound, which constitutes the auditory index; the oscillation of the needle and the alteration of the sound varied together very strongly."

It was the difference in the mean pressures that was noticed in the diabetics, especially in those with retinopathy; the same applies to the diastolic readings.

Oscillometer Index.—This is one of the best clinical methods of measuring the extensibility (*i.e.*, partly the elasticity) of the arteries of both wrists and ankles. In a normal young person the lower extremities have a larger, or at least equal, index to that of the wrists. It is different with advancing age. See Pines (1946) on physiological angiospasm of the retinal arteries. I had the opportunity of examining a man aged 44 years, with advanced nephritic retinopathy; the following were his readings:

$$\text{R.W.}^{*}\frac{220(210)}{150\text{-}2}\text{ m/170} \qquad \text{L.W.}_{*}\frac{210(200)}{150\text{-}2}\text{ m/170}$$

Oscill. index, R.A.* 7, L.A.* 3.

Up to 25 per cent. the difference of the oscillometric index may still be reckoned as a physiological one; higher than that—in my opinion—it is pathological. While, therefore, a certain amount of angiospasm of the lower extremities is seen in advanced hyperpietics, it is more accentuated in diabetics and extremely so in retinopathics. In fourteen cases of retinopathy, I saw it in twelve; on the other hand, I had fifteen diabetics with angiospasm, and in twelve I saw also the retinopathy—86 per cent. in the former

*R.W. = Right Wrist
*R.A. = Right Ankle
*L.W. = Left Wrist
*L.A. = Left Ankle

and 80 per cent. in the latter. Age makes no essential difference. (See Table, p. 309.)

Case Histories

Mrs. Z. I., aged 79 years

R.W. $\frac{200(190)}{90\text{-}7}$ m/110 L.W. $\frac{190(180)}{90\text{-}4}$ m/100(110?)

R.A. 3½, L.A. 4½; fasting blood sugar 140. Diabetic for 8 years, taking 14 units of insulin daily; advanced sclerosis of the retinal vessels, no retinopathy.

Mrs. D., aged 65 years, on the other hand

R.W. $\frac{220(210)}{70\text{-}4}$ m/90 L.W. $\frac{180(170)}{70\text{-}4}$ m/90

B.A.* nil; fasting blood sugar 182. Diabetic for 14 years, taking 38 units of insulin daily. Both fundi—advanced sclerosis of the retinal vessels. No retinopathy. Examined again in two months' time, she gave the reading:—

R.W. $\frac{160}{80\text{-}5}$ m/115; B.A.—1; both eyes—*idem.*

Mrs. S., aged 56 years, diabetic for 10 years; fasting blood sugar 220; taking 60 units of insulin daily

R.W. $\frac{220(210)}{120\text{-}6}$ m/140 L.W. $\frac{200(190)}{100\text{-}2}$ m/120

B.A. ½; R.E.* retinopathy with haemorrhages and exudation.

This is a peculiar form of angiospasm, occasionally accompanied by intermittent claudication of which this patient complained.

A man aged 59 years, on the other hand

R.W. $\frac{230}{90\text{-}4}$ m/110 L.W. $\frac{230}{90\text{-}5}$ m/110

B.A. nil; fasting blood sugar 133, diabetic 4½ years, taking 6 units of insulin daily, was quite happy.

A man aged 44 years, however,

R.W. $\frac{140}{90\text{-}3}$ m/120 L.W. $\frac{140}{90\text{-}3\frac{1}{2}}$ m/120

R.A. 2½; L.A. 5; diabetic 2 years, taking 24 units of insulin daily; (fasting blood sugar not known); R.E. retinopathy with considerable amount of exudation and a few small aneurysms, had intermittent claudication in his right leg. One must take into consideration that his mean pressure was rather high as well, and that the combination of both factors probably produced the claudication.

It is important to note that in my series of cases, a few were suffering from old gangrene of the toes of both feet.

Such was *H. S., a man aged 70 years,* diabetic for 12 years, taking 37 units of insulin daily. His readings were

R.W. $\frac{160}{90\text{-}5}$ m/100 L.W. $\frac{150}{85\text{-}6}$ m/105

R.A. 2; L.A. ½; lentic opacities. No retinopathy. Three months afterwards his readings were

R.W. $\frac{180}{80\text{-}4\frac{1}{2}}$ m/155 L.W. $\frac{180}{80\text{-}4\frac{1}{2}}$ m/140

R.A. 2; L.A. 1; urine sp. qs. 1,025; sugar plus; albumin—fasting blood sugar 200 mg.

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*B.A. = Both Ankles *R.E. = Right Eye

A woman, aged 59 years, diabetic 20 years, taking 20 units of insulin daily, gallop rhythm of heart due to splitting of the second sound, had an initial gangrene of both big toes. Her readings were

$$\text{R.W.}\ \frac{170}{90\text{-}3\frac{1}{2}}\ \text{m}/110 \qquad \text{L.W.}\ \frac{160}{90\text{-}4}\ \text{m}/110$$

R.A. 4; L.A. 4. Diabetic retinopathy of both eyes, but no haemorrhages.

In my opinion, the gangrene in these cases was due to disturbance of the capillary, not of the arterial, circulation. The angiospasm then is really an arterial reaction of local or general aetiology, quite separate from the height of blood pressure, but more frequently seen in combination with hypertension, probably because the arteries then are more easily excited and react more violently. Plesch (1937) also points out that normally the arteries are distended about 100,000 times in 24 hours and, provided these are not distended too much, their elasticity does not suffer. *X* ray of the lower limbs, performed in a few cases of advanced angiospasm, showed diffuse calcification of the arteries of the calf. As the reader may observe above, the process may be reversible. The contrary may also occur.

An old man, a non-diabetic and a heavy smoker, with a past history of pulmonary tuberculosis, had, when seen at his home, the oscillometer index of both ankles, 1 or 1½. Admitted to the London Jewish Hospital and put to bed, he had an index of ½ in the left ankle, with blood pressure of 140 and 1 with 120. But in the right ankle, he had ½ with 120 and nil with 140.

While the upper limbs are usually immune, no completely satisfactory explanation is available as to why the lower limbs should be chiefly affected, but it is a well-known clinical fact. There are many factors causing it—the upright walking position, longest distance from the heart, difficulties of venous outflow, etc.

Here, in conclusion, is a case of extreme hypertension combined with a mild diabetes.

Mrs. E. T., aged 57 years, had had 12 children. She was slightly cyanotic, easily dyspnoetic on very mild exertion, and had been a diabetic for 1½ years. Fasting blood sugar was 125 on June 5, 1947, and 100 on February 10, 1948. She was taking 33 units of insulin daily.

$$\text{R.W.}\ \frac{280}{130\text{-}3\frac{1}{2}}\ \text{m}/180 \qquad \text{L.W.}\ \frac{270}{130\text{-}3}\ \text{m}/200$$

B.A. 1. Fundi showed severe degeneration of the arteries, which were thin, tortuous, nearly silver wire. Hour-glass compression of the veins by the arteries, no haemorrhages or exudation seen.

It is obvious from the Table that the age of the retinopath is actually lower than that of the average diabetic, and that the retinopaths have a longer history of disease than the diabetics.

TABLE

Particulars of Groups Discussed

Group	Normal Persons (5)	Hyperpiesis		Diabetes (40)					
		Mild (5)	Advanced (5)	Without retinopathy (26)			With retinopathy (14)		
				Average	Males	Females	Average	Males	Females
Average Age ...	26	52	56	61	59	62	57	50	58
Duration of Disease (years)	—	—	—	10	5	12	13	6	14
Fasting Blood Sugar	—	—	—	189	176 5/6	194	198 11/14	225	186
Insulin (units)	—	—	—	29	25	30	32 3/12	25	30
Blood pressure									
Systolic R.W.	122	176	200	175	149	186	154	180	149
L.W.	122	164	196	166	137	177	173	170	175
Mean R.W.	100	116	134	106 1/3	100	111 1/3	120	115	121
L.W.	110	116	134	101 1/2	97 1/2	106 1/2	109	120	106 2/3
Diastolic R.W.	88	100	120	91	84	94	98 8/14	105	97 6/12
L.W.	88	100	120	87	73	92	94 9/14	85	91 7/12
Oscillometer									
R.W.	2 9/10	4 3/4	3 2/3	3 1/2	4 1/2	3 27/30	3 8/14	4 1/2	3 5/12
L.W.	3	4 2/3	4 5/10	3 28/40	4 4/10	3 28/30	3 9/14	3 3/4	3 4/12
R.A.	4 1/2	4 7/10	3 9/15	2 1/2	4 3/11	2 5/30	1 12/15	1 1/4	2 1/12
L.A.	4 1/2	4 6/10	2 3/5	2 25/40	4 4/11	2 18/30	1 21/28	2 1/4	1 6/13

R.W. Right Wrist. L.W. Left Wrist.
R.A. Right Ankle. L.A. Left Ankle.

Discussion

In estimating the oscillometer index, we have to compare that of the lower extremities with that of the wrists, but especially the difference between both ankles.

The diabetic who develops a retinopathy is a definite type where the most prominent sign is angiospasm of both lower extremities. The opinion of Ballantyne and Michaelson (1948) is different—" in diabetes there is no discovered correlation between the fundal picture and the age of the patient, the blood pressure, or the severity of the disease." As quoted in the *Traité d'Ophtalmologie*, some authorities had 58 retinopaths in 398 diabetics. Grafe (1923)

saw 80 in 500; Folk and Soskin (1935) had 33 per cent.; and Taubenhaus (1935) some haemorrhages in 40 per cent., but in 80 per cent. when they were hyperpietics. Redslob (1948) saw retinopathy in 31 diabetics of 52 to 78 years of age, and none in 51; Hanum (1938) saw retinopathy in 195 cases out of 966. Duration of diabetes is 5 years for retinopathy according to Krause (1930) and 10 years according to Braun (1935, etc.). Redslob estimates glycosuria as 150-250 mg. Elwyn (1945) quotes 45 diabetics of an average age of 55 years (24 to 73; 33 females, 12 males); there was mild nephritis in eight, arterial hypertension in fifteen, arterio-sclerosis in thirteen, lenticular opacities in eleven, and retinopathy in 25; the average systolic pressure was 154 (96-270), the diastolic 85 (60-130), and fasting blood sugar 84-289 (average 141). According to Ballantyne and Michaelson, in a large series of diabetic patients with retinal changes, over 50 per cent. had no abnormality of blood pressure. Other writers quoted by Redslob and the *Traité d'Ophtalmologie* found evidence of general arterio-sclerosis (athero-sclerosis?) in 45 diabetics and retinopathy in 25, and Braun (1935, etc.) found the percentage of arterio-sclerosis equal between diabetics and non-diabetics of the same age. But Altnow (1927) found that this sclerosis starts with diabetics at 33 years and with non-diabetics at 57. Dry and Hines (1941) found retinopathy in 47 per cent. of the diabetics, but in 17 per cent. of the retinopaths there were no signs of arterio-sclerosis. Hanssen (1929), Doggart (1930), Foster-Moore (1915), and Gradle (1926) are of the opinion that retinopathy is of arterio-sclerotic origin. Shephardson and Crawford (1931) deny the connection of retinopathy with diabetes and ascribe it only to arterio-sclerosis. Franceschetti and Streiff (1939) found hypertension in 87 per cent. of 13 retinopaths, and two-thirds of them had a very high diastolic pressure. Vom Hofe saw 45 cases of retinopathy, 32 of them with hypertension; Hanum (1938) found 75 per cent. of hypertension in 35 cases of retinopathy. Onfray (1918, etc.) saw three patients with normal blood pressure in 24 retinopaths. Mylius (1936) does not think that hypertension has any connection with retinopathy. Crocco (1932), Cammidge (1930), and Braun (1935, etc.) found only 43 hypertension cases in 111 cases of retinopathy. Weill (1938) found the systolic pressure over 150 in 72 per cent. of retinopaths; but 37 per cent. of his diabetics had no retinopathy. In the opinion of Kaufmann and Cosla (1940), over 50 per cent. had no abnormality of blood pressure. Schmid (1939) thinks that hypertension helps to develop a retinopathy. Volhard (1931), Arruga (1932), and others think that retinopathy develops only with hypertension. More than 85 per cent. of the retinopaths in *Traité d'Ophtalmologie* were hypertensive and in 30 per cent. the kidney function was damaged. Yet in

my series of forty diabetics, fourteen had a retinopathy (35 per cent.), 28 being females and twelve males (females 70 per cent., males 30 per cent.). Among the females were twelve retinopaths (30½ per cent.) but only 5 per cent. out of all the forty diabetics were males; the average age was nearly four years lower than in average diabetics (61-57); 9 in males, and 3½ in females. The mean blood pressure and the diastolic pressure were definitely higher in the retinopaths. The systolic pressure is of little importance; it is not connected with the rise of the diastolic and the mean pressure. *The retinopathy in my cases is definitely connected with mild hypertension and advanced angiospasm of the lower extremities.*

The kidney function was not damaged, as measured by blood urea in some cases (Pines, 1931). I still maintain that the real test of a special form of kidney damage is oedema of the retina. On the other hand, nephrosclerosis will be present in all cases of general sclerosis, but nephritic retinitis was not seen in any of my cases, even with the highest blood pressure (280/130).

The Possible Mechanism of Diabetic Retinal Angiopathy

Pathology.—Wolff (1944) states that the earliest change is the presence of fatty droplets in the endothelial cells of the retinal veins and capillaries; phlebosclerosis of the larger veins with later hyalination of the walls; some noxious chemical agent in the blood stream and almost specific to certain cases of diabetes is responsible for the changes in the vessels, particularly the veins, venules, and capillaries. Ballantyne and Michaelson (1948) found that the changes begin with fatty infiltration and swelling of the endothelium of the smaller vessels and proceed to capillary and venous stasis. Elwyn (1945) feels that the small retinal haemorrhages observed in diabetes have no relation to the vascular changes of aging, sclerosis, hypertension and obstruction of the veins, but are rather dependent on pre-static condition of the capillaries of the retina, which is in some way related to moderate hyperglycaemia. Redslob (1948) thinks " that the haemorrhages are produced by diapedesis, that the veins and capillaries are showing sclerotic changes in their walls with hyaline degeneration." The white spots are formed by fibrin round the vessels but does not represent necrotic foci, but he quotes the opinion of Beauvieux and Pesme (1923) that the haemorrhages are due to hyperglycaemia, and the white spots to impairment of the kidneys. L. Russo (1925), Lawrence (1936), and Staupendahl (1926) saw endarteritis obliterans of the small vessels. Bonnet and Bonamour (1938) think that the veins are chiefly attacked; the same is the opinion of Dry and Hines (1941).

According to *Traité d'Ophtalmologie* the changes in the diabetic

arteries are chiefly a preponderance of cholesterine and calcium. Hyperglycaemia injures the endothelium, cholesterine impregnates it, and calcium helps to obliterate the arterioles. The veins are attacked not only in the retina, but in the choroid as well. The haemorrhages are situated in all layers of the retina, including that of the pigment epithelium, and rods and cones. The exudate is fibrinous.

The Ophthalmoscopic Picture.—This is chiefly represented by white spots of exudation, minute venous aneurysms, as first explained by Ballantyne, and various forms of retinal haemorrhages. Sclerosis of the arteries is present (as opposed to that of the veins) only when the blood pressure is raised. But I would like to draw attention to a peculiar shining reflex, slightly similar to the water-silk reflex of the young, that is seen in some peculiar forms of advanced hyperpiesis—due, in my opinion, to sclerotic changes in the capillary bed, and not connected in cases of diabetic angiopathy with the degenerative changes in the arteries, as in the following case.

A man, aged 44 years, diabetic for two years, blood sugar unfortunately not established, had the following readings

$$\text{R.W.}\ \frac{140}{90\text{-}3}\ \text{m/120} \qquad \text{L.W.}\ \frac{140}{90\text{-}3\frac{1}{2}}\ \text{m/120}$$

R.A. 2; L.A. 5, with intermittent claudication in the right calf; R.E. a considerable amount of exudation near the macula and a small aneurysm at or near a small independent vein. L.E. starting degeneration of the macula and a small aneurysm at 3 o'clock. B.E. peculiar reflex from the retina of both eyes.

The exudation, as is well known, is waxy in appearance, sharply limited and hardly changeable. In hypertension the exudation is usually not far from a large vein or artery, more bluish in appearance, and has more rugged borders; after a week or two in the majority you see newly formed capillaries encroaching from the periphery. I have seen nothing of this kind in diabetic angiopathy. Sometimes, in about two cases out of fourteen, there was exudation, but no haemorrhage; in the rest they were combined with aneurysms, as pointed out by Ballantyne. Undoubtedly he and Loewenstein are right in saying that this is, at present, the earliest manifestation of retinopathy. I applied the dynamometer of Bailliart in many cases—without measuring the intra-ocular tension—but did not find any peculiar difference in cases of arterial hypertension. I cannot agree with the opinion of Espildora-Lugue (Sorsby, 1948) that there is no brachial hypertension without increase of the retinal pressure. These cases are fortunately rare. The patient is very giddy, and liable to have coronary thrombosis. Here is the record of one illustrative case.

Mrs. B., aged 60 years, with essential hyperpiesis for years; advanced retinal sclerosis. From time to time—foci of retinomalacia. Very giddy.

R.W. $\frac{230(220)}{120\text{-}3}$ L.W. *idem,* B.A. 3. Intra-ocular tension 15.

In sitting position Bail. R.E. 25, *i.e.,* Mean 20.
L.E. 25, *i.e.,* Mean 20.

In recumbent position Bail. R.E. 40(35).
L.E. 45(40).

Died within a year from two attacks of coronary thrombosis.

For this reason Bailliart's reliable method did not show any special results in diabetic angiopathy, which is due to a capillary degeneration, not to an arterial one.

Venous Pressure.—The primordial difficulty of measuring venous pressure is in the retina, and its intricate connection with the intra-ocular tension. That is why anybody who tries to do it is really measuring the intra-ocular tension or the tension in the ophthalmic vein—the latter being already part of the brain system.

Until a method is found to dissociate the venous pressure and the intra-ocular tension from each other, the result for both is nearly equal. That is why I cannot agree with the opinion of Fritz (1946) and others.

The general venous pressure as examined by a large bore needle, introduced in the cubital vein of the patient and connected with a special manometer, was found within normal limits—14-16 cm. of water for the female, and up to 16-18 cm. for the male. Again the result is not surprising, as a raised venous pressure is the earliest sign of impending heart failure and has nothing to do with diabetes.

Capillary Circulation.—In my opinion, the vascular tree, anatomically, may be the same everywhere in the body, but physiologically and pathologically it is nothing of the kind. This chief difficulty in clinical examination is greatly increased when we come to speak of the capillary bed, and especially that of the retina. Plesch is right when he expects a very intimate connection between the local capillaries and products of cellular metabolism (" metabolites "). The capillaries of the lungs are specially adapted for oxygen metabolism, those of the liver for glycogen, etc. Even about the capacity of the capillary bed, opinions are widely divergent (See Plesch, 1937, as against Krogh). The capillaries of the soles of the feet are probably adapted to withstand an enormous outside pressure—otherwise necrosis of the soles would occur in the standing position. The capillaries of the skin can withstand, according to Wright (1945) a pressure of 100 mm. of mercury—an incredible pressure for retinal capillaries.

Thus, at least as far as the retina is concerned, we have no methods at all of measuring their vital capacities directly. But one fact emerges strongly: in the lower extremities of retinopaths we have to deal with angiospasms of the arteries and arterioles, but not of the capillaries. More than that (in two cases, where the patient had an incipient or a definite gangrene of the big toe and of the soft parts of the toes, there was no angiospasm of the arteries at all, and in the majority of the cases of extreme or advanced angiospasm there was no gangrene of the toes) the two conditions may be, and often are, quite separate. Moreover, as mentioned previously, in diabetic retinal angiopathy the ophthalmoscopically visible arteries are not much changed, unless the blood pressure is raised but the exudation and minute venous aneurysms are already present and situated usually below the nerve fibre layer, or the patient is advanced in age (senile changes).

I would say that the extent of exudation and haemorrhages in diabetes is connected with little degeneration—of primary and secondary arterial branches—just the opposite to what is usually seen in arterial hypertension, where the exudation and haemorrhages usually appear after the degeneration of the arteries is very advanced indeed.

According to the *Traité d'Ophtalmologie*, Safar (1935) thinks that the lesions are chiefly those of small blood vessels, invisible by the ophthalmascope. In short, contrary to those of the lower extremities, the capillaries of the retina are involved and the arteries are not. How can one explain it? I think it is axiomatic that the tissues fated to do harder work are naturally constructed to withstand the strain. A baby is born with the skin of his soles thicker than that of the rest of the body; the structure of the aorta is different from that of the medium arteries, etc. All the arteries and capillaries in the body are built to withstand a considerable pressure from inside, because on the outside the pressure is not higher than that of the venous pressure—18 cm. of water. The pressure inside the brain, as expressed in the figures of cerebrospinal liquid pressure, is also very low. " A high venous pressure gradient would necessitate a high capillary pressure and give rise to excessive pulsation in the veins, which would seriously damage the elastic properties of the walls of those vessels " (Plesch, 1937). And this is so with the retina, even in normal cases. The blood vessels of the eye, including those of the retina, are caught between the non-elastic sclera and non-elastic gel of the vitreous body and are constantly subjected to an *outside* pressure of 15-18 mm. of mercury, right from the late period of the intra-uterine life. Supported continuously by a very considerable pressure from outside, they have no need to develop powerful vascular walls and

therefore are more easily affected than those in other parts of the body. On the other hand, this may explain the fact that the cerebral vessels of a hyperpietic, not supported from outside, rupture much more frequently than the retinal ones—a striking contrast with diabetics. The vascular system of the kidney with its capsule more elastic than that of the sclera, but less than that of the spleen or liver, may be in a similar position; taking that and the very similar structure of the nephron and the retina in its relation to the vascular system (see Pines, 1931, on renal nephritis) into consideration, one wonders if this is not a possible clue to the striking parallelism of the pathology of the retina (not choroidea) and of the kidney. And the newest form of nephritis, described as due to sclerosis of the smaller vessels between the glomeruli, may it not be explained by angiospasm of those vessels? Already Leber (1916) has stated that " the retinal changes in true or albuminuric retinitis can recede if the basic pathological process in the kidney is healed or improved. In good cases even highly advanced retinal changes can recede completely ".

After the experiments of Trueta and his co-workers this remarkable capacity of the kidney is easily explained by the angiospasm of its vascular tree.

I repeat the same opinion now (but with, I believe, an anatomical basis): hyperpietic retinopathy is due to sclerosis of the larger arteries and arterioles; renal retinitis is due to the attack of the toxin on all branches of the vascular tree and their spasm; diabetic retinopathy attacks chiefly the capillary bed and the venous system.

Angiospasm is chiefly the attribute of renal and diabetic retinopathy and of toxaemia of pregnancy.

Whatever it is, I think that the intra-ocular tension makes the walls of the retinal arterial system more fragile, and the capillaries are, of course, the weakest link in the chain. The veins again suffer because they must have an intravenous pressure much higher than usual, as the outflow of blood must be able to overcome the intra-ocular tension. There is then a vicious circle—a system with weak muscular walls must be able to develop a fairly high intravascular tension. Two additional factors come into play. One is the fact that with the vascular spasm of the lower extremities the inflow of blood to the upper part of the body is increased. The oscillometer readings of both wrists in the Table well demonstrate this. The other is even more important: the exudation in retinopathy is fibrinous; there is no necrosis, and it is stationary for months, if not longer. Admittedly I did not examine the visual fields of my diabetics for scotomata (a really necessary additional factor), but the absence of retinal necrosis means only

one thing, that the circulation is still going; and it means that the capillaries, degenerated, are closing and opening up again, a form of angiospasm. If this be so, what will happen to the venules? Their walls are weakened by the unknown toxic factor and subjected to a sudden increase in the inflow of blood, not sufficient to burst them, but sufficient to form an aneurysm. I described and illustrated in sclerosis of the retinal vessels (Pines, 1929) a similar venous aneurysm in even a strong vein, which being crushed by an artery, formed this aneurysm on the proximal side of the crossing, where the blood stream, after passing under an artery, strikes and dilates a weakened venous wall. To that must be added the generous venous stasis due to the diminished *vis a tergo* of capillary pressure, conditioned by the degeneration of the capillary walls and added angiospasm. Then the peculiar and rare tortuosities of the veins, as described and illustrated by Ballantyne and also by Lowenstein, may be due not only to the degeneration of their walls but also to the diminished *vis a tergo* and to the undiminished intra-ocular tension at their exit from the retina at the disk. It would stimulate the well-known phenomenon of a briskly flowing stream of water, less tortuous than the sluggish one. The tremendous haemorrhages of the final stage are due to the rupture of the large veins, and not to diapedesis.

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CONGENITAL ENTROPION DUE TO EPIBLEPHARON*

BY

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CONGENITAL entropion is a rare malformation of the eyelid and for that reason this case is worth publishing. Among the 160,000 patients of the University Eye Clinic Debrecen in the last 25 years many cases of epiblepharon have been observed, but among them this is the only one in which we had to deal with real entropion.

A boy, aged 7 years, was seen on August 5, 1948. The parents stated that both lower lids had been turned in since birth, and the eyelashes touched the globe; for two years his left eye has been reddened and there was a sore place on it.

Visual acuity in the right eye 5/5, in the left 5/7. All along the right lower lid there was a skin-fold. The cilia were not directed horizontally but upwards, though they did not touch the globe. Apart from this, the eye was normal. On the left lower lid one could see a similar fold, and the eyelashes—as the Figure shows—were inverted, rubbing against the cornea. The bulbar conjunctiva was

Eyelashes of the left side rubbing against the cornea.

hyperaemic. Traumatic pannus was present on the lower third of the cornea, and there was mild iritis. On the upper lip at the left border of the philtrum there was a vertical scar due to an operation for hare lip.

On August 7, 1948, we operated on the left eye. Kettesy's modification of the Celsus-Hotz operation was performed. On cutting a 5 mm. broad skin-strip out of the lower lid we found the palpebral part of the orbicular muscle hypertrophic as in senile entropion. We excised the hypertrophic part, exposed the tarsal plate, and then put in Hotz's sutures. After six days the patient left the clinic with the lid in normal position. In eight months the condition had not relapsed.

According to the text-books epiblepharon and congenital entropion are different malformations. A skin-fold in infants, generally in the lower lid, is considered to be epiblepharon.

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Elschnig (1922) thinks that faulty fixation of the skin to the tarsus or to the tarso-orbital fascia is the cause of it. The skin-fold itself, is able to bring about the condition, according to Bachstez (1916) whereas Müller (1932) attributes the main role to the fibres of the inferior rectus muscle.

Many papers have been published about the congenital defects of the lower and upper lids. In the cases of Müller (1932), Bartha (1932), Bachstez (Case 1, 1916), and others, epiblepharon was the only malformation, whereas Chow (1935), Arkin (1935), and others mention many and various congenital deformities of the body.

There is some controversy as to whether epiblepharon itself may cause an entropion or whether there is also some other factor. In Müller's opinion the muscle is able to invert the tarsus, thus giving rise to an entropion. Our case supports this, as we found a hypertrophy of the palpebral part of the orbicular muscle.

It seems to me that muscular hypertrophy is independent of the skin-malformation. Comparing the two lower lids in the Figure, we see the fold much more marked on the left side. There is no muscular hypertrophy on the right side, and no entropion, but on the left side where the hare-lip was present, we found it. I think the primary cause of the entropion in this case is congenital muscular hypertrophy. The many cases of epiblepharon without entropion seem to confirm this view.

Congenital inversion of the cilia disappears usually without any intervention in the first two years by the change of the elasticity of the skin and by the development of the face, but in cases where other malformations (epicanthus, muscular hypertrophy) are associated, the inversion may remain stationary.

In my opinion we may speak of congenital entropion only in cases when the inversion of the eyelashes is permanent, and this boy is an example of the condition.

Summary

A case of congenital entropion successfully operated on is reported. The deformity was caused by hypertrophy of the palpebral part of the orbicular muscle.

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AN UNUSUAL CASE OF RETINAL DETACHMENT*

BY

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London

THIS is an account of an instructive case of retinal detachment.

Case history

B. N., a man aged 48 (packer and despatcher), was sent to one of us (J. G. M.) at hospital on November 2, 1949, by Dr. G. F. Ensor of Bishop's Stortford. The story was that one week previously the patient noticed a shadow in the upper field of vision of the right eye. The following day he saw Dr. Ensor, who diagnosed a detached retina. The patient came to hospital six days later. He said that two days after seeing Dr. Ensor the shadow had increased considerably in size.

Examination.—There was only a grey reflex in the right eye, the pupil was semi-dilated, and gave a very sluggish reaction to light, and there was no perception of light. The retina appeared to be almost completely detached, there was a suspicion of a faint reflex at the extreme periphery at 12 o'clock. Nothing else could be made out. The eye was moderately myopic (5D).

In the left eye vision was 6/18 $\bar{c}$ $\frac{-4{\cdot}5 \text{ sph.}}{-0{\cdot}5 \text{ cyl. } \searrow 140^{\circ}}$.

Fundus normal. The left had always been the weaker eye. It seemed probable that this was a simple detachment unlikely to be improved by operation, but we decided to admit him for a few days' rest to see if there was any change in the fundus appearance. After six days there was hardly any change, the faint reflex above, noted at the first examination was, perhaps, slightly more obvious, and there was faint perception of light. It was decided to evacuate the sub-retinal fluid. This was done on November 9, 1949, by cautery puncture in the 7-30 meridian 12 mm. from the limbus. A quantity of brown fluid escaped, much darker than the usual straw-coloured sub-retinal fluid. Some of this was collected for microscopical examination. It subsequently revealed red cells, a few white cells, but no malignant cells.

Ophthalmoscopic examination immediately after the operation showed the retina in place above, there were considerable folds of detachment elsewhere. Trans-illumination was quite clear all over the globe. Two days later the upper half of the retina was in place, and there was a fairly large field of vision; below at 5 o'clock was a large solid growth with some small haemorrhages on its surface. The eye was excised.

Pathological Report.—"Situated in the lower nasal quadrant of the choroid and extending over the equatorial region there is a spindle-celled malignant melanoma of the choroid. Pigmentation is moderate to heavy in places, there are numerous blood sinuses and the reticulin development is heavy. Invasion of the sclera has taken place, but there is no evidence of extra-ocular extension."

(N. Ashton, Institute of Ophthalmology).

Comment

From the patient's history (he seemed to be an intelligent observer) and the fact that he was myopic, our first impression was that here was a simple detachment with sudden increase in extent

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involving the whole globe. Transillumination was perfect. There was no reason to suspect a neoplasm, and the sudden rapid deterioration described by the patient was against a detachment secondary to neoplasm, and in favour of a simple detachment; particularly as the cause of the rapid loss of field was not a vitreous haemorrhage but a greatly enlarged area of retinal separation.

It would have been easy to explain the situation to the patient and to have sent him away.

The lesson to be learned, therefore, is that in all cases where a view of the fundus cannot be obtained it is advisable to withdraw sub-retinal fluid if by so doing there is a chance of obtaining information. This should be done by aspiration if a neoplasm is suspected.

PRIMARY TUBERCULOSIS OF THE CONJUNCTIVA*

BY

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UNTIL 1922, the possibility of a primary tuberculous affection of the conjunctiva, in any of its clinical forms, was a debatable problem. Most of the observers, before that date, considered the healthy conjunctiva a barrier to the entrance of the bacilli, and consequently that all cases of tuberculosis of the conjunctiva were either endogenous in origin, the infection arriving through the blood stream, or an extension of infection from a neighbouring affected tissue. In 1922, Igersheimer found that if tubercle bacilli were dropped in the conjunctival sacs of healthy guinea-pigs, these usually developed a conjunctival lesion and invariably a lymphadenitis. Subsequently many other workers (Lange, 1924; Bruckner, 1929; etc.) confirmed these findings and thus the possibility of a primary tuberculous affection of the conjunctiva was accepted.

Origin.—Tuberculous lesions of the conjunctiva may arise as follows:

(1) Exogenously (*a*) as a primary infection.
(*b*) as a superimposed infection in a patient already suffering from tuberculous disease elsewhere.

(2) Endogenously from an established remote focus.

(3) By Direct Extension, from a tuberculous lesion of a neighbouring tissue, such as the skin and nose in lupus, or the sclera, lacrimal sac, or orbit.

Tubercle bacilli reaching the conjunctiva by any of these three routes may cause a tuberculous conjunctivitis in one of the recognized five clinical forms, the ulcerative type, the nodular type, the hypertrophic papillary type, the polypoid type, and the conjunctival tuberculoma. The main difference between a primary lesion and a superimposed infection is the marked regional lymphadenitis which nearly always accompanies the former. Though this view is not generally accepted, especially by those workers who study the subject from an experimental standpoint, yet in nearly all recorded cases, with an established diagnosis of primary tuberculosis of the conjunctiva, a marked regional lymphadenitis was also present.

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Case Incidence.—Tuberculosis of the conjunctiva, as a primary lesion or a superimposed infection, is a rare condition. Only isolated cases have been reported in America (Coover, 1920; Cohen, 1919; Thompson, 1906; McKenzie, 1939; Sitchevska and Sedan, 1943). Ivanov (1939) stated that only two cases were seen in the Moscow eye clinic in 1935 among 94,000 patients. Samuelson (1936) observed, during the years between 1915 and 1934, seven patients with tuberculosis of the conjunctiva, three of which were primary infections, among 181,000 patients seen at the ophthalmic clinic of the Seraphimer hospital in Stockholm. Blegvad (1936) encountered forty cases of primary tuberculosis of the conjunctiva during the years 1909 to 1934 in the Finsen Institute in Copenhagen. He believes that this frequent occurrence of tuberculosis of the conjunctiva was due to the prevalence of tuberculosis in cattle in Denmark. In Egypt, 33 cases of tuberculosis of the conjunctiva were observed during the years between 1925 and 1948 amongst the patients attending ophthalmic hospitals all over the country.

Location. — According to Willard, tuberculous lesions of the conjunctiva affect the palpebral conjunctiva in 70 per cent. of cases, the bulbar conjunctiva in 22 per cent. of cases, and the fornix in 8 per cent. of cases. In Egypt, out of the 33 cases noticed between 1925 and 1948, 40 per cent. were in the bulbar conjunctiva, 48 per cent. in the palpebral conjunctiva, and 12 per cent. in the fornix.

Age and Sex.—The disease is most frequent in the first 20 years of life. Twice as many women as men are affected. Out of the 33 cases noticed in Egypt between 1925 and 1948, only four were above 20 years of age, one being only 4 months old. 70 per cent. of the cases were in males and 30 per cent. in females, which is contrary to the general incidence in other countries.

Differential Diagnosis.—The diagnosis is only made certain by biopsy, guinea-pig inoculation, and the discovery of the bacillus in smears or in tissue sections. The histological appearance on biopsy is the most important as the actual tubercle bacillus was only found in 25 per cent. of the cases reported in the literature on examination of the secretion or the excised tissue. The Mantoux test, though unreliable, was positive in 99 per cent. of cases.

Case Report

K. M. S., a boy aged 10 years, was first examined at the Memorial Ophthalmic Laboratory on May 2nd, 1949.

History of Present Illness.—On December 4th, 1949, he attended Ashmoun Ophthalmic Hospital suffering from a small painful swelling of the bulbar tissues below the limbus of the left eye. The nodule was yellow in colour and the neighbouring conjunctiva was injected and chemosed. The movements of the

(*a*) (*b*)

FIG. 1.—Condition before treatment.

globe were normal. The cornea and deeper media were clear and the fundus appeared normal. The pupil was normal in size and reaction. L.V.=6/9. The right eye was normal. R.V.=6/9.

The nodule was incised at Ashmoun o.h. under the impression that it was a "pustule." The condition subsequently deteriorated and the patient was referred to the Laboratory for investigation.

Previous Medical History.—The patient has suffered from dry cough and night sweating for some months. He was twice treated for bilharzia.

Family History.—The father and mother are both living. His six brothers are all in good health. (All were subsequently examined and pronounced free from active tuberculosis).

Condition on First Examination at the Laboratory.—The child was thin and anaemic. Weight 24·5 K.G. Height 130 cms.

Right eye: No apparent abnormality. R.V.=6/9.

Left eye: Below the limbus and extending towards the lower fornix was a raised roughly circular mass of conjunctival tissue. Almost the entire surface of the affected area was ulcerated and the edges were rolled and indurated. The mass was softish and firmly attached to the sclera. The cornea, anterior chamber, iris, lens, and vitreous were normal. The fundus showed a detachment of the retina down. The tension of the eye was normal. The preauricular and submaxillary lymph nodes on the left side were enlarged and tender. The upper third of the left visual field was lost.

The differential diagnosis lay between tuberculosis, schistosomiasis, syphilis, and new growth. A primary tuberculous infection seemed to be the most probable and this was confirmed later by histological examination of a biopsy specimen.

Laboratory Examinations:

(1) *X*-ray examination of the chest showed "infiltration around the hilum of the right lung which is not definitely tuberculous". A second radiologist

gave the following report: "A triangular, fairly dense, homogenous shadow is seen in the base of the right upper lobe with its apex peripherally and its base in close contact with the hilum of the lung. This shadow is suggestive of epituberculosis".

(2) The sputum examined on three successive days was negative for tubercle bacilli.

(3) Zeihl Neilsen preparation from the ulcer was negative.

(4) A piece of the ulcer for biopsy was excised and examined. The sections showed numerous tubercle nodules but no caseation. In some sections, giant cells of the Langhans type are seen. The picture was that of a low grade tuberculous inflammation.

(5) The guinea pig inoculation showed:
(*a*) no caseous local lesion at site of injection;
(*b*) no pathological lesion and no enlargement of spleen;
(*c*) no pathological lesion in liver and lung;
(*d*) enlarged sublumbar lymph glands were excised for histo-pathological examination. This showed a tuberculous infection.

(6) The urine contained bilharzia ova.

(7) The stools were negative.

(8) Wassermann reaction and Kahn test were negative.

(9) A smear from the ulcer was negative for spirochaetae.

(10) A gram-stained smear showed xerosis bacilli. The culture showed the same organisms.

(11) The blood picture was:

Haemoglobin	66 per cent.	
R.B.Cs.	4,560,000.	
W.B.Cs.	6,800.	
D.B.C. Polymorphs	46	per cent.
Eosinophiles	7	per cent.
S. lymphocytes	22	per cent.
L. „	20	per cent.
Hyaline	5	per cent.

Thus the case was diagnosed as a tuberculous ulcer of the conjunctiva, probably primary in nature. The initial surgical interference had presumably injured the sclera and spread the infection inwards causing a secondary detachment of the retina.

Therapy.—Treatment with Dihydro-streptomycin was started on May 14th, 1949, and continued for 25 days. The equivalent of 1 g. streptomycin was given daily in divided doses, 0·4 g. in the morning, and 0·6 g. in the evening, by deep intramuscular injection. The drug was well tolerated. No other treatment was given during this time.

After the end of the treatment with streptomycin, the local condition of the eye was much improved. About 90 per cent. of the ulcerated area had healed, and about 70 per cent. of the retinal detachment had disappeared. The mass, though diminished to nearly half the original size, was still raised.

Ultra-violet therapy was then begun with local application to the affected conjunctiva of one to two minutes every third day, and general radiation of the body also every third day.

Result.—In October, 1949, the condition was as follows. The upper two-thirds of the mass has completely disappeared. Scar tissue is apparent in the sclera underneath the conjunctiva. The lower third near the fornix was still slightly raised with a small polypoid mass present. The submaxillary lymph nodes were non-palpable. The left pre-auricular lymph glands were still palpable, but small and not tender. The detachment of the retina has completely disappeared, leaving a pigmented scar in the extreme lower periphery near the ora serrata.

The left vision was 6/12 without correction, and the visual field was complete.

FIG. 2.—Condition one month later, after treatment with streptomycin.

FIG. 3.—Final condition four months later.

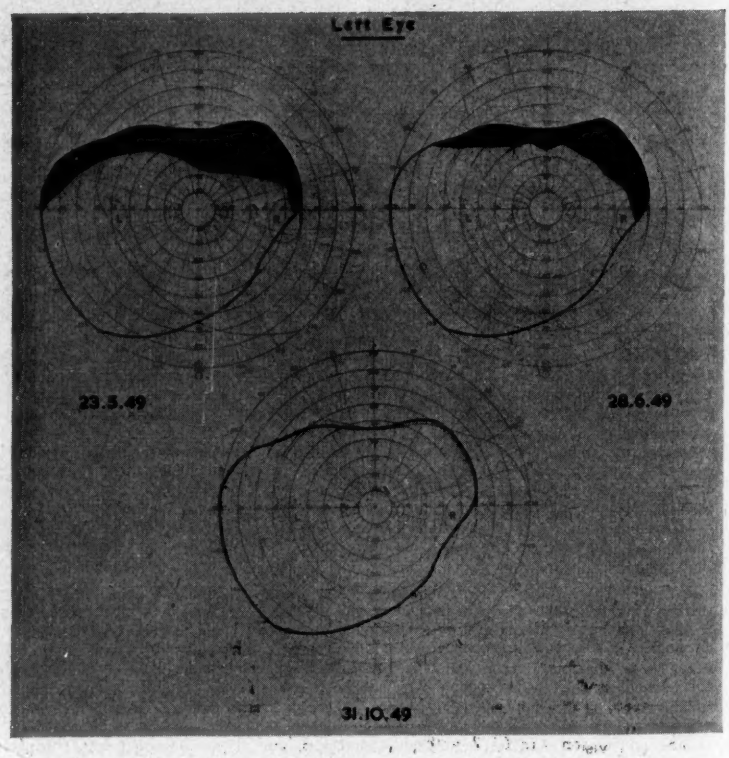

FIG. 4.—Fields of vision taken before treatment (23-5-49), after streptomycin treatment (28-6-49) and (31-10-49).

Conclusion

The case is considered cured, as the ulcer has completely healed, the subretinal extension has resolved with re-attachment of the retina, and most of the bulk of the subconjunctival mass has disappeared, with healing of the scleral wound. There is no doubt that this result is mostly due to the effect of streptomycin although the amount given was comparatively small. Ultra-violet therapy probably aided in the completion of the healing process. Considering the severity of the lesion and its extension intra-ocularly, I do not think that without the aid of streptomycin we could have saved this eye as a useful seeing organ, and in so short a time.

Summary

1. A case of tuberculous ulceration of the conjunctiva with accidental intra-ocular extension is described.

2. The case was treated with streptomycin and ultra-violet therapy with a successful end result.

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NOTES

The Treacher Collins Prize Essay

UNDER the above title, the Council of the Ophthalmological Society of the United Kingdom has instituted a Prize of £100, awarded triennially, for the best essay submitted upon a subject selected by the Council.

The prize shall be open to qualified medical practitioners of any nationality.

The essay shall be written in the English language.

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The closing date for sending in essays for this award is September 30, 1951. Essays should be submitted to the Honorary Secretary, Ophthalmological Society of the United Kingdom, 45 Lincoln's Inn Fields, London, W.C.2, from whom also any further particulars can be obtained. No name should be on any essay, but a distinguishing pseudonym or quotation, which should be upon a sealed envelope containing the candidate's name and address, should accompany the essay.

Honours

Congratulations are offered to the recipients of the following distinctions:

Mr. H. B. STALLARD, M.B.E., F.R.C.S., received the honorary degree of LL.D. from the University of St. Andrews on April 20, 1950.

Mr. J. H. DOGGART, F.R.C.S., and MR. T. KEITH LYLE, F.R.C.S., have been elected Honorary Members of the Ophthalmological Society of New Zealand.